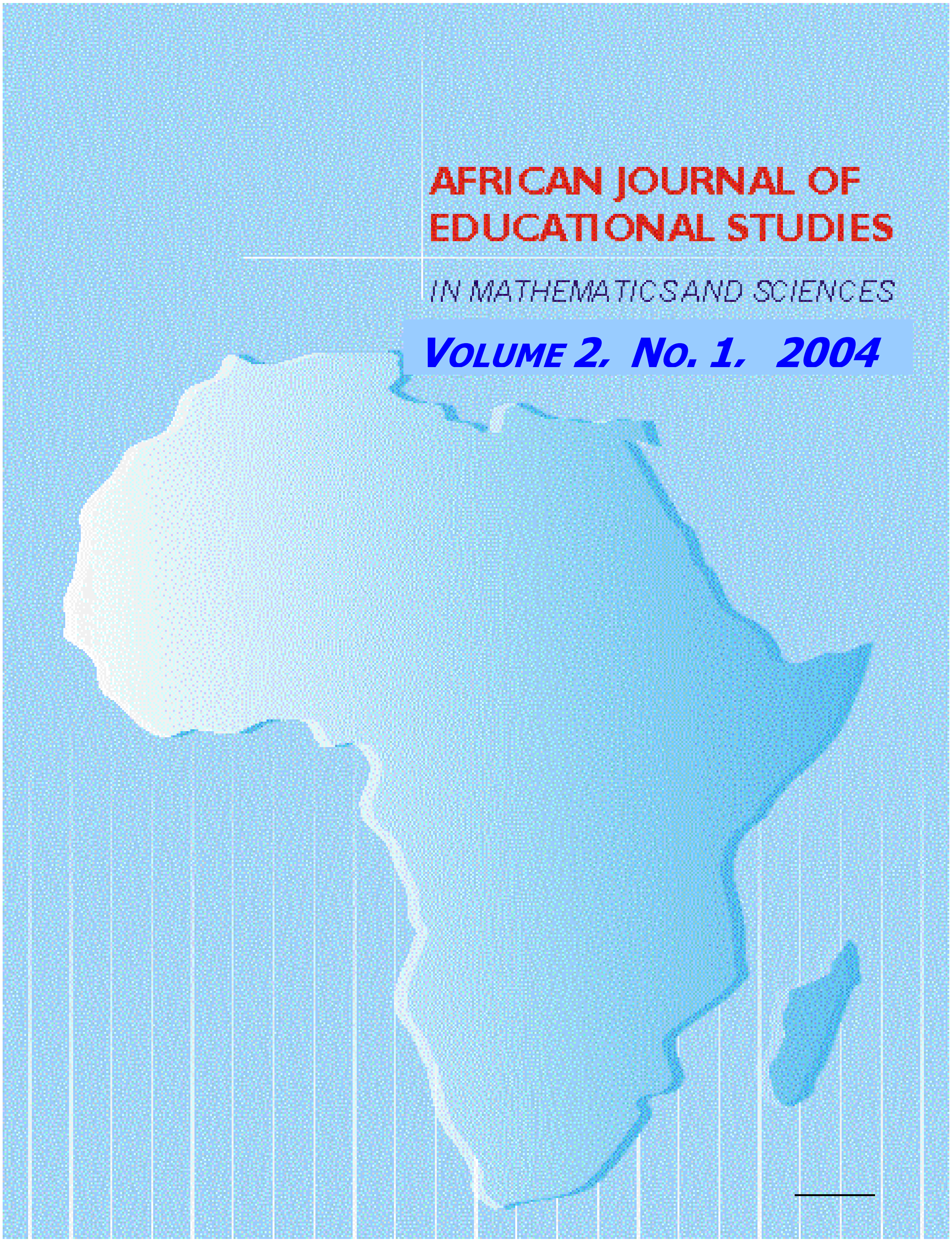
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EDITORIAL

The African Journal of Educational Studies in Mathematics and Sciences (AJESMS) is an interdisciplinary reputable international journal that provides a forum for researchers and educators in science and mathematics and related disciplines to present and disseminate their findings.

Like the maiden volume, this volume has articles that were carefully selected by an editorial team of adept professors in science and mathematics education from a host of articles received across the globe. The selected articles were reviewed by science and mathematics educators of international repute to maintain standards.

In this volume, eight papers of wide diversity are published. In the first paper, Asiedu-Addo and his team of researchers discuss mathematical models in biology, their formulation and usage in analysing mechanisms involved in biology. In the second article, Onabanjo and Okpala have discussed the effects of peer tutoring-assisted instruction, parent supportiveness and students locus of control on achievement in senior secondary school mathematics in the Odogbolu and Ijebu-Ode Local Government areas in the Ogun State of Nigeria. Additionally, in this volume, Norgu and Yager have spotlighted some discordant notes on the STS-constructivist reform.

Following the furore that went on in Ghana over the Language Policy in teaching at the primary school, Johnson Nabie and Ernest Ngman-Wara assessed the competence and use of Ghanaian Language in teaching at the basic level in the Upper West Region of Ghana and recommended strongly the consideration by policy implementers of the linguistic competence of teachers before they are posted to basic schools. Onivehu and Ziggah's article 'Breaking the mathematics phobia of secondary school students using behaviour modification techniques' proposes a model, Behavioural Modification Techniques, in teaching mathematics at the senior secondary school.

The other papers presented in this volume include a proposal on the contextualization of science and technology education on the African continent. Anamuah-Mensah and Asabere-Ameyaw, ardent believers in the contextualization of teaching, expertly discussed the constraints to contextualization of the teaching of science and technology in Africa and proposed a model that could integrate endogenous and formal science and technology knowledge in the teaching of science and technology in African schools for accelerated development of the continent in their paper. In a case study report on the treatment duration of topics in core mathematics, Asare-Imkoom and Gyening have concluded that the 160 minutes per week for 96 teaching weeks for the senior secondary core mathematics programme in Ghana is highly inadequate for effective teaching and learning at that level. In the last paper in this volume, Avoke in his 'Curriculum, quantitative concepts and methodology of teaching children with learning difficulties' argued the need to address learning needs of pupils with learning difficulties and proposed the development of quantitative concepts and survival arithmetic through differential experiences.

These articles are all and must read. The Editorial Board of AJESMS believes that science and mathematics educators, researchers and all those who advocate improved educational systems in Africa and enhanced teaching and learning of mathematics and science, should find AJESMS very educative and useful.

Dr. A. Asabere-Ameyaw
(Managing Editor)

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Mathematical Modeling in Population Dynamics: The Case of Single Species Population

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Abstract

The growth and decline of population in nature and the struggle of species to predominate over one another has been a subject of interest dating back through the ages. Applications of simple mathematical concepts to such phenomena were noted centuries ago. This paper discusses mathematical models in biology, their formulation, analysis and interpretation. Much emphasis is placed on how appropriate assumptions simplify the problem, how important variables are identified and how differential equations are tailored to describing the essential features of a continuous process. The trust of this paper is the application of mathematical models in helping to unravel the underlying mechanisms involved in biological and ecological processes.

Introduction

In contemporary society, almost all domains of human knowledge have to apply mathematical and computational methods. Mathematics is thus “sine quo non” in the area of science and technology. Biology is a natural science that deals with the study of living things and their interactions with their environment. In their study biologists make use of mathematical models containing differential equations which enable them come out with laws regarding the behavior of living things in relation to their environment. The increasing study of realistic mathematical models in ecology (basically the study of the relation between species and their environment) is a reflection of their use in helping to understand the dynamic processes involved in such areas as predator-prey and competition reactions, multi-species societies and ecological control of pests.

The increasing use of mathematics in biology is inevitable as biology becomes more quantitative. Mathematical biology research, which has direct impact on agriculture development, is useful and functional as an academic activity to pursue. From mathematical point of view, the art of good modeling relies on:

First: A sound understanding and appreciation of the biological problem;

Second: A realistic mathematical representation of the important biological phenomena. That is the variables involve must be carefully defined and the governing laws identified. The mathematical model is the some equations representing an idealization of the physical laws, taking into account some simplifying assumptions in order to make the model tractable.

Third: Finding useful solutions. When permitted, exact solutions are usually desired, but in many cases, one must rely on appropriate solutions, using numerical techniques.

Fourth: A biological interpretation of the mathematical results in terms of insights and predictions is then given. That is the solutions obtained should be consistent with physical intuition and evidence.

The Biological Problem

Human activities have brought about drastic changes in the global environment. One grave consequence of this is the increased incidences of biological invasions and growth. In nature, all organisms reproduce, migrate or disperse and go to extinction. These processes can take a diversity of forms as in walking, swimming, flying or being transported by wind or flowing water. Dispersive movements become noticeably active when an offspring leaves its natal sites, or when an organism's habitat deteriorates from overcrowding. Seen from a geological time scale, the geographical distribution of species on the earth's surface has changed each time a large-scale climatic or geomorphological change has taken place (Cox and Moore, 1993). These changes have resulted in geographical separations in a species' range, at times causing further speciation.

Mathematical Formulation

The spatial spread of an invading species can basically be seen as a process in which individuals disperse while multiplying their numbers. One model in which dispersal is formulated as a random diffusion process is the Fisher's equation. Assume that a few individuals invade the center of a two-dimensional homogenous space. If $n(x,t)$ denotes the population density at time t and spatial coordinate $x=(x,y)$, the Fisher's equation in two-dimensional space is expressed as

$$\frac{\partial n}{\partial t} = D\left(\frac{\partial^2 n}{\partial x^2} + \frac{\partial^2 n}{\partial y^2}\right) + (\varepsilon - \mu n)n \,. \quad (1)$$

The left-hand side of this equation indicates the change in the population density with time, which is caused by random diffusion and local population growth, expressed respectively by the first and second terms on the right-hand-side. D is the diffusion coefficient, which is a measure of how quickly the organisms disperse. The population growth is

formulated by the logistic growth function, where ε is the intrinsic rate of increase and $\mu(\geq 0)$ represents the effect of intraspecific competition on the reproduction rate. Fisher (1937) first proposed this equation as a model in population genetics to describe the process of spatial spread when mutant individuals with higher adaptivity appear in a population.

The Diffusion Model

If a range expands solely by diffusion without population growth, the Fisher equation (1) becomes the so-called diffusion equation in two-dimensional space:

$$\frac{\partial n}{\partial t} = D\left(\frac{\partial^2 n}{\partial x^2} + \frac{\partial^2 n}{\partial y^2}\right). \qquad (2)$$

In this model, let the number of individuals that invade the origin at time $t = 0$ be n_0. Then the initial distribution is given by $n(x,0) = n_0 \delta(x)$.

Here, $\delta(x)$ is the delta function, which indicates that the probability of finding an individual is concentrated in the immediate vicinity of the origin. Under this initial condition, the diffusion equation (2) has a solution:

$$n(x,t) = \frac{n_0}{4\pi Dt}\exp\left(-\frac{x^2 + y^2}{4Dt}\right), \qquad (3)$$

which is the two-dimensional Gaussian (or normal) distribution.

Let $r = \sqrt{x^2 + y^2}$, the radial distance from the origin to a point (x, y), then equation (3) is rewritten as a function of r and t:

$$n(r,t) = \frac{n_0}{4\pi Dt}\exp\left(-\frac{r^2}{4Dt}\right). \qquad (4)$$

Here, $n(r,t)$ expresses the population density of an arbitrary point on a circle of radius r.

Logistic Model

The model above describes the spread of population by diffusion alone. If conversely the population changes by growth (i.e. reproduction), alone without diffusion, equation (1) becomes the so-called logistic equation. Thus we shall have:

$$\frac{dn}{dt} = (\varepsilon - \mu n)n\,, \qquad (5)$$

where $n(r,t)$ is the population density at time t for some fixed location. The expression $(\varepsilon - \mu n)$ represents the per capita growth rate, which declines linearly with the density. The intrinsic rate of increase ε is the growth rate (i.e., difference between the birth rate and death rate) when

density is low, while μn represents the density effect on the reproductive rate. As the density grows, competition for food or space increases, either directly through interactions between individuals or directly by exploitation of resources, resulting in the decline of the rate of reproduction.

Let $k = \frac{\varepsilon}{\mu}$, then equation (5) becomes

$$\frac{du}{dt} = \varepsilon\left(1 - \frac{n}{k}\right)n, \qquad (6)$$

where k is the *carrying capacity* of the environment, which is usually determined by the available sustaining sources. If there is no competition within the species (i.e. $\mu = 0$), the logistic equation becomes the so-called Malthusian equation

$$\frac{dn}{dt} = \varepsilon n, \qquad (7)$$

whose solution is given by

$$n(t) = n_0 e^{\varepsilon t}, \qquad (8)$$

where n_0 denotes the initial density. When $\varepsilon > 0$, the population increases exponentially without limit. On the other hand when competition exists within the species (i.e., $\mu > 0$), the solution for equation (5) is given as:

$$n(t) = \frac{n_0 k e^{\varepsilon t}}{k + n_0 (e^{\varepsilon t} - 1)}. \qquad (9)$$

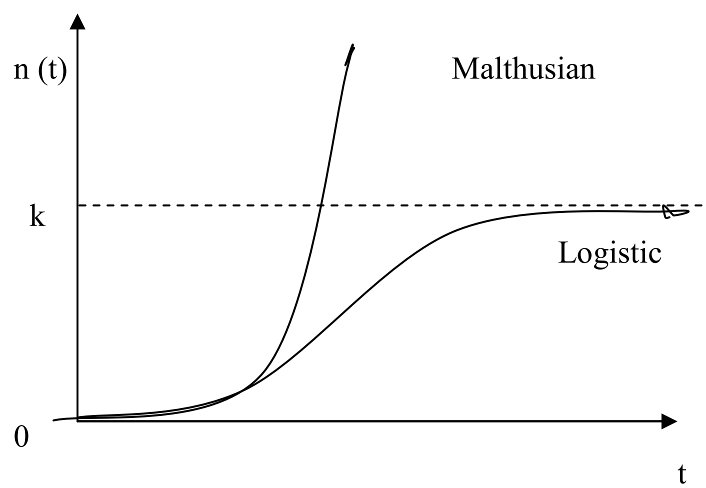

Fig. 1 Solution of Malthusian equation and logistic equation.

Figure 1 shows the change in density over time as given by equations (8) and (9). Initially when the density is low, the curves for both equations increase exponentially. With increasing density, the effect of compition becomes apparent in the logistic equation, with the growth rate slowing down after the density reaches half the carrying capacity, and eventually the density asymptotically approaches the carrying capacity k.

There are two steady states or equilibrium states for equation (6) namely $n=0$ and $n=k$ where $\frac{dn}{dt}=0$. The steady state $n=0$ is unstable since liberalization about it gives $\frac{dn}{dt}\approx \varepsilon n$ and so n grows exponentially from any initial value. The other steady state $n=k$ is stable.

Linearization about it gives

$\frac{d(n-k)}{dt}\approx -\varepsilon(n-k)$ and so $n\to k$ as $t\to\infty$.

From equation (6), if $n_0<k$, $n(t)$ simply increases monotonically to k. In this case there is a qualitative difference depending on whether $n_0>\frac{k}{2}$ or $n_0<\frac{k}{2}$.

With $n_0<\frac{k}{2}$, the form has a typical sigmoid character. If $n_0>\frac{k}{2}$, $n(t)$ decreases monotonically to k. (See Fig. 2). This implies that the per capita rate is negative. The carrying capacity k determines the size of the stable steady state population while ε is a measure of the rate at which it is reached.

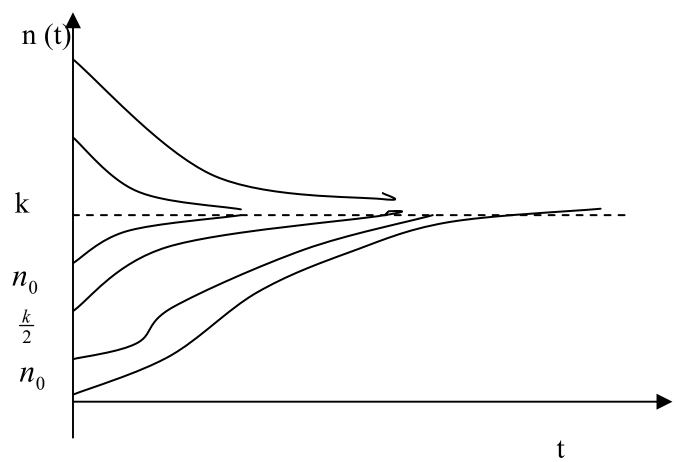

Fig. 2 Logistic population growth.

Generalization

To place both of the above into a somewhat broader context, we proceed from a more general assumption, that for an isolated population (no migration) the rate of growth depend on the population density. Therefore we write that

$$\frac{dn}{dt} = f(n)\,. \qquad (10)$$

In this model, we consider the function f as an infinite power (Taylor) series as sufficiently smooth:

$$f(n) = \sum_{i=0}^{\infty} a_i n^i = a_0 + a_1 n + a_2 n^2 + a_3 n^3 + \cdots$$

Thus any growth function may be written as a (possibly infinite) polynomial (Lamberson and Biles, 1981). In equation (10) we require that $f(0) = 0$ to dismiss the probability of spontaneous generation, the production of living organisms from inanimate matter (Hutchinson, 1978). In any growth law this is equivalent to

$$\left.\frac{dn}{dt}\right|_{n=0} = f(0) = 0\,.$$

In this case assume that

$$a_0 = 0$$

$$\frac{dn}{dt} = a_1 n + a_2 n^2 + a_3 n^3 + \cdots$$

$$= n(a_1 + a_2 n + a_3 n^2 + \cdots) = ng(n)\,.$$

The polynomial $g(n)$ is the intrinsic growth rate of the population. The function $f(n)$ in equation (10) is nonlinear so the steady state solutions $\overline{n}$ are solutions of $f(n) = 0$.

There may be several steady state solutions depending on the form of $f(n)$. The gradient $f'(\overline{n})$ at each steady state then determines its linear stability. These steady states solutions are linearly stable to small perturbations if $f'(\overline{n}) < 0$ and unstable if $f'(\overline{n}) > 0$.

Because of its simple structure and explicitly solution, the logistic equation has been widely employed in theoretical work and in empirical studied to describe the growth of populations both in the field and under laboratory conditions (Brown and Rottry, 1993).

References

Brown, D. and Rothery, P. (1993). *Models in Computing* Mathematics, *Statistics and Computing,* New York: Wiley.

Cox, C.B and Moore, P.D. (1993). *Biogeography. An Ecological and Evolutionary Approach*, 5th edition, Oxford: Blackwell.

Edelstein-Keshet, L. (1988). *Mathematical Models in Biology*, New York: Random House.

Fisher, R. A. (1937). The wave of advance of advantageous genes. *Annals of Eugenics*, **7**, pp255-369

Hallam,T. G and Levin, S. A (1986). *Mathematical Ecology: An Introduction*. New York: Springer-Verlag.

Hengeveld, R. (1989). *Dynamics of Biological Invasions*. London: Chapman and Hall,.

Hoppensteadt, F. C. (1982). *Mathematical Methods of Population Biology.* Cambridge: Cambridge University Press.

Hutchinson, G.E. (1978). *Introduction to population Ecology.* New Haven, Conn: Yale University Press,

Lamberson, R and Biles, C. (1981). Polynomial models of biological growth, *UMAP Journal,* 2 (2) pp 9-25.

Murray, J.D. (1993). *Mathematical Biology*. Berlin: Springer-Verlag.

Shigesada, N. and Kawasaki, K. (1997). Biological Invasions: Theory and Practice, Oxford: Oxford University Press.

Peer Tutoring – Assisted Instruction, Parent Supportiveness and Student Locus of Control – as Determinants of Academic Achievement in Senior Secondary School Mathematics

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Abstract

The study investigated the effect of peer tutoring-assisted instruction, parent supportiveness and students locus of control on achievement in Senior Secondary Mathematics. It adopted a non-randomized pretest posttest control group design in a quasi experimental setting. It involves 300 senior secondary II students from six coeducational secondary schools in Odogbolu and Ijebu – Ode Local Government Areas of Ogun State Nigeria. The data collected were analysed using analysis of Covariance (ANCOVA). The findings revealed that there was significant main effect of treatment (peer tutoring) on mathematics achievement, it also revealed a significant interaction effect of treatment and parent supportiveness on achievement in mathematics. The three way interaction was founded not to be significant. The implication and recommendations were made.

Introduction

The Nigerian society is aware of the importance and tremendous application of scientific knowledge. It is well known that without science, there is no technology and without mathematics there is no science (Fajamidagba, 1996). Science Technology and Mathematics (STM) are important and mutually dependent therefore, there is need to embed mathematical, scientific and technological knowledge in everyday life.

Mathematics has been highlighted as a very important subject which is experiencing difficulties and the state of mathematics in Nigeria is a matter of concern. The low levels of attainment of students in mathematics at every segment of educational system have given mathematics and even mathematics educators a high level of concern which is so because of the universally held assumption of the importance of the subject to the growth and development of mankind (Akinsola, 1999).

A lot of research efforts have been focused on identifying factors that inhibit the learning of mathematics and against students' performance in senior secondary mathematics. Inadequate number of qualified and interested

teachers have been identified as one of the problems, gender stereotyping, motivation, Lecture method have been highlighted as part of the problems. Adepoju (1991) describes the approach used by many teachers of mathematics as one which does not give room for students to develop their intuition, imagination and creative abilities.

There are also indications the parents constitute a powerful body that can influence the overall performance of the child and that the traditional approach to teaching mathematics (the lecture method) has failed to deal effectively with the problems of individual differences in mathematics. It has also failed to provide for the students' appreciation and understanding of learning as a continuing aspect of modern learning theory which stresses students' active involvement in the teaching learning process. There is therefore need to search for more effective instructional strategies that are likely to improve achievement in senior secondary mathematics. Such strategies perhaps, include cooperative based learning instructional strategies which have been found to improve science learning outcomes (Oebukonla, 1984; Iroegbu, 1998; Slavin 1990) and that peer tutoring is a type of cooperative based learning institutional strategy.

Peer tutoring is a personalized system of instruction which is learner rather than teacher oriented, it emphasizes active students participation in the learning process. It is an individualized attention to a learner, the tutee, by a person of similar status (e.g. with respect to age, educational experience etc.) who serves as the tutor. Studies have revealed that peer tutoring as an instructional strategy benefits both the students being tutored and the tutor, although the tutor is associated with greater cognitive gains than students being taught (Annis, 1982, Bargh and Schul 1980; lambiotte et. al., 1987).

This study also focused on the effect of parent supportiveness, students' locus of control and gender on the achievement of students in senior secondary mathematics. Parent supportiveness is the support given to the students by their parents and these supports include the obligation of parents toward their children (i.e. providing food, clothing, shelter, materials necessary for learning as well as parents' involvement in regular checks of what is being taught in school) and the provision of direct instruction to the students when necessary. Students' locus of control can be expressed as the extent to which a person believed that reinforcement was contingent upon ones own behaviour (internal). Also, considering the fact that gender stereotyping is still very much in Nigerian learning environment (Onocha, Okpala and Offorma, 1995) the study also sought to evaluate the effects of gender on students performance in senior secondary mathematics.

It is against this background that this study was designed to assess peer tutoring-assisted instruction, (treatment), parent supportiveness, students' locus of control as determinants of achievement in senior secondary mathematics.

Research Hypotheses

Specifically, the study sought to test the following hypotheses:

(1) Mathematics achievement of

a. students exposed to peer tutoring-assisted instruction (treatment) will not be significantly higher than that of students in the control group.

b. students of high parent supportiveness is not significantly higher than that of student of low supportiveness.

c. male students is not significantly higher than that of female.

d. students who are internal is not significantly higher than their counterparts who are external.

(2) Achievement in Mathematics is not significantly affected by interaction of:

a. treatment and parent supportiveness.

b. treatment and locus of control.

c. treatment and gender.

(3) Achievement in Mathematics is not significantly affect by interaction of:

a. treatment, parent supportiveness and locus of control.

b. treatment, parent supportiveness and gender.

c. treatment, parent supportiveness, locus of control and gender.

Methodology

Design

The study made use of a pretest-posttest non-randomized control group design in a quasi-experimental setting which the treatment (as three levels) was crossed with parent supportiveness (two levels), student locus of control (as two levels) and gender (at two levels).

Sample

The sample consisted of 300 senior secondary school two (SSII) students (137 female and 163 male) from six randomly selected co-educational secondary areas of Ogun State Nigeria. The students were exposed to three levels (101 for peer tutoring conventional teaching, 99 for peer tutoring alone and 100 for conventional teaching alone).

Instrumentation

The study made use of three valid and reliable instruments. The Mathematics achievement test (MAT) (KR. 20=0.081), Parent Supportiveness Questionnaire (PSQ) with inter-rater value of 0.85 and student locus of control scale (LOC) with reliability coefficient of 0.79.

Procedure

The Mathematics teachers of the participating schools were first trained on how to use the treatment package. These teachers then made the students to respond to the three instruments: the LOCS, the PSQ and MAT. The LOCS scores were used in classifying the students into two locus of control grouping: internal and external, the PSQ scores served the purpose of classifying the students into two groups of parent supportiveness. Low and High. The MAT scores served as pre-test (covariate scores). After this, the teachers provided the treatment conditions to the experimental and control groups (simple random sampling was used to decide the specific treatment provided for each intact class of a selected school). The treatment lasted for six weeks at the end of which the teachers administered the MAT as post-test.

The three treatment groups were as follows:

1. **Experimental Group 1:** The treatment in this group consisted of teacher instruction and peer tutoring. First the students were exposed to teacher instruction, which consisted of the four procedural steps: preamble, exposition, remediation and summary. Next, the group were exposed to peer-tutoring and this involved peering the students in groups of four with one of them serving as the tutor. The teacher requested that peer tutoring be used to re-study the lesson taught (under teacher supervision).

2. **Experimental Group 2:** The treatment in this group consisted peer tutoring alone. The students were peered in groups of four with one of them serving as the tutor. The peer tutored group studied the lesson topic under the teacher's supervision.

3. **Control Group:** The treatment in this group consisted of the normal conventional method of teaching (i.e. teacher instruction alone)

Data Analysis

The posttest achievement scores were subjected to analysis of covariance using pretest scores as covariates. The Scheffe test and graphical illustrations were employed as post-hoc measures to disentangle interactions effects where necessary.

Results

Table 1 shows data from the analysis of covariance of mathematics achievement using pre-test achievement scores as covariate. The table shows significant main effect of treatment ($F_{(2,299)}$ = 215.488, $P<0.05$). Parent supportiveness, locus of control and student gender were found not to have significant main effect on student achievement in mathematics. The results revealed a significant interaction effects were found not to be significant.

Table 1: Summary of Analysis of Covariance of Students Achievement Scores by Gender, Locus of Control, Parent Supportiveness and Treatment

Source of Variation	**Sum of Square**	**DF**	**Mean Square**	**F**	**Sing. of F**
Covariates	5.038	1	5.138	0.392	0.532
Pretest	5.038	1	5.038	0.392	0.532
Main Effect	5581.465	5	1116.263	86.860	0.000
Gender	0.430	1	0.430	0.33	0.855
Locus of Control	8.388	1	8.233	.653	0.420
Parent Supportiveness	19.942	1	19.942	1.552	0.214
Treatment	5538.764	2	2769.382	215.488	0.000*
2-Way Interaction	12.213	9	14.357	1.117	0.351
Gender x L.O.C.	0.202	1	0.202	0.016	0.900
Gender x Parent Sup.	0.462	1	0.462	0.36	0.850
Gender x Treatment	7.641	2	3.820	0.297	0.826
LOC x Parent Sup.	0.619	1	0.619	0.048	0.826
LOC x Treatment	46.999	2	23.500	1.829	0.163
Parent Sup. X Treatment	74.658	2	37.329	2.905	0.054*
3-Way Interaction	181.1962	7	25.995	2.023	0.52
Gender x Loc x Par. Sup	25.976	1	25.976	2.021	0.156
Gender x Loc x Treatment	70.677	2	35.339	2.750	0.66
Gender x Parent Sup. X Treat.	38.276	2	19.138	1.487	0.227
LOC x Parent X Treatment	36.168	2	18.084	1.407	0.247
4-Way Interaction	6.287	2	3.143	0.245	0.783
Gender x Par. Sup LOC x Treatment	9.287	2	3.143	0.245	0.783
Explained	5903.965	24	245.999	19.141	0.000
Residua	3534.205	275	12.85233		
Total	9438.170	299	21.566		

*Denote Group significant at P<0.05

The Multiple Classification Analysis, MCA (Table 2), reveals that the direction of increasing effect of instructional strategy (treatment) on mathematics achievement is conventional < peer tutoring alone < peer tutoring + teaching while the adjusted mean scores of the groups are 22.90, 30.13 and 33.02 respectively. The MCA in all reveals a multiple R squared value of 0.592 and beta value of 0.78, 0.05, 0.03 and 0.01 for treatment, parent supportiveness, locus of control and gender respectively. Further analysis of the data on significant main effect of treatment on student achievement is reported in table 3 which shows that significant difference in students achievement exist between students exposed to conventional method and peer tutoring, conventional method and teacher _ peer tutoring as well as between those exposed to peer-tutoring and teaching + peer tutoring. There are indications that student achievement in mathematics could be significant improved by peer tutoring assisted instruction and peer tutoring respectively.

Table 2: Multiple Classification Analysis (MCA) of Achievement Scores by Gender, Locus of Control, Parent Supportiveness and Treatment

Variable + Category	N	Unadjusted Deviation	ETA	Adjusted for independent + Covariate	BETA
Gender					
1. Girls	137	.05		0.04	
2. Boys	163	-.05		-0.03	
			0.01		0.01
Locus of Control					
1. External	184	-0.02		-0.17	
2. Internal	152	0.02		0.17	
			0.00		0.03
Parent Supportiveness					
1. Low	112	0.48		0.34	
2. High	188	-0.29		-0.20	
			0.07		0.05
Treatment					
1. Teaching + Peer Tutoring	101	4.33		4.45	
2. Peer Tutoring	99	1.43		1.44	
3. Conventional	100	-5.79		-5.92	
			0.76		0.78
Multiple R square					0.592
Multiple R					0.769

Table 3: Scheffe Multiple Range Test of Achievement on Treatment

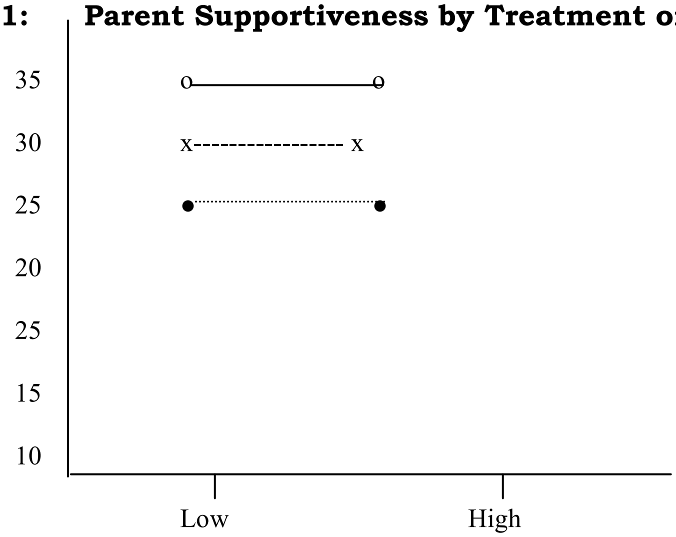
		Groups		
Mean	**Group**	**Conventional**	**Peer tutoring**	**Teaching + Peer tutoring**
22.9000	Conventional			
30.1212	Peer tutoring	*		
33.0198	Teaching + Peer tutoring	*	*	

*Denotes pairs of group significantly different at 0.05 level

Furthermore, the significant interaction effect of treatment and parent supportiveness is disentangled. This is illustrated graphically in Figure 1, which shows ordinal interaction. Students that were exposed to peer tutoring + teaching performed best irrespective of their parent supportiveness level and the students that were exposed to peer tutoring alone did better while the students that were exposed to conventional method performed least. The students that were exposed to conventional

teaching, whose parent supportiveness is high did better than the students that were exposed to conventional method with low parent supportiveness.

Figure 1: Parent Supportiveness by Treatment on Achievement



Where x …x is Peer tutoring; o——o is Teaching + Peer tutoring; and ●------● is Conventional method

Discussion and Conclusion

The main effect of peer tutoring, parent supportiveness locus of control and gender on students' achievement in Mathematics was only significant for the treatment and was not significant for parent supportiveness, locus of control and gender.

The significant main effect of treatment on student achievement in Mathematics agrees with the finding of Okebukola (1984, 1985) and Iroegbu (1998). The report on studies that assessed the effect of peer tutoring on academic achievement of college students have demonstrated that the instructional strategy benefit both the students being tutored and the tutor.

Frantuzzo et al. (1992) also support the use of peer tutoring for mathematics gains. Students that are exposed to peer tutoring in addition to the conventional method of teaching will gain more in mathematics and are likely to perform better than the students who are exposed to only conventional methods. The non-significant main effect of parent supportiveness, locus of control and gender is at variance with the view of Ojedele (1992), Igwe (1991) and Erinosho (1994) and tend to agree with Esho (1998) and Ross (1998).

The significant interaction effect of treatment and parent supportiveness on student achievement in secondary school mathematics revealed that when conventional method is used, the teacher should concentrate more on the students that have low parents supportiveness because the study shows

that the peer tutoring plus teaching is also good for students from low parent supportiveness.

This tend to corroborate the finding of Miller and Kelly (1991) who also found no significant interaction between treatment and locus of control and between treatment and gender. The three-way and four-way interaction were found not to be significant on student academic achievement.

In all, the independent variables (treatment, parent supportiveness, student locus of control) and moderator variable (gender), when taken together could be used to explain 59.2% of variation in secondary school mathematics achievement of the students a level of explanation that is considered significant ($P<0.01$). The order of the contributions of the variables to the explanation is treatment (62.4%) followed by parent supportiveness (0.25%), locus of control (0.09%) and the least is gender (0.01%).

In the light of all the results and the associated discussion, we share the view that peer tutoring assisted instruction has the potential to improve students' achievement in mathematics and it is thus suggested that practicing mathematics teachers in secondary schools should use peer tutoring as an integral part of instructional strategy in mathematics classroom. The nature of the significant interaction effect of treatment and parent supportiveness on mathematics achievement provides the empirical basic for suggesting the use of the treatment in classrooms irrespective of students' level of parent supportiveness. The treatment could also play a remedial role for mathematics students who are disadvantage because of their low parent supportiveness. It is hoped that the implementation of these recommendations would lead to our ultimate goal of improved secondary students' enrolment in science courses in higher institution as well as their performance in mathematics at the secondary school level.

References

Adepoju J.A. (1991) 'Factors and Problems in the Teaching and Learning of Mathematics in Nigeria Schools'. *National School curriculum Review Conference Proceedings*. Lagos; Federal Ministry of Education.

Akinsola, M.K. (1999). 'Effects of Instruction on Students Performance on Knowledge, Comprehension and Sand Application Tasks in Mathematics'. *African Journal of Educational Research 5(1)*, 94-99

Annis; L.E. (1982). *The Cognitive Benefit of Peer Tutoring*. Paper Presented at the Meeting of the American Educational Research Association, New York.

Annis, L.E. (1983). 'The Process and Effects of Peer Tutoring' *Human Learning. 2*, 39-47

Bargh; J.a. and Schul, Y.I. (1980) 'Cognitive Benefit of Teaching'. *Journal of Educational Psychology 72*, 593-604

Erinosho,S.Y. (1994) *Perspective on Women in Science and Technology in Nigeria,* Ibadan, Sam-Bookman

Eso, O.T. (1998) *Assessment Procedures and Locus of Control Paradigm as Determinant of Students Achievement in Integrated Science*. (Ph.D. Research Proposal) University of Ibadan

Fajemidagba, O. (1996) School Mathematics and Mass Education in Nigeria; the Result of an Exploratory Study in Samuel Ayodele (ed). *Education in the Service of Humanity*.

Frantuzzo J.W. king, J.A. and Heller L.R, (1992) 'Effects of Reciprocal Peer Tutoring on Mathematics and School Adjustment: A Component Analysis'. *Journal of Education Psychology 84*, 331-339

Igwe, G. O. (1991) *Impact of Behavioral Objectives, Cognitive Entry Behavior and Locus of Control Paradigm on Student Learning Outcomes*. (Unpublished Ph.D Thesis) University of Ibadan

Iroegbu (1998) *Problem based learning, numerical ability and gender as determinant of Achievement, Problem Solving Line-Graphing Skills in Senior Secondary Physics* in Ibadan. (Unpublished Ph.D. Thesis) University of Ibadan

Lambiotte, J.G. Dansereau, D.f., O'Donnel, A.M. Young, M.D. Skars, L.P. Hall and Rocklin, T.R. (1987) 'Manipulating Cooperative Scripts for Teaching and Learning', *Journal of Education psychology, 79,* 424-430

Miller, D.L. and Kelly, M. (1991) 'Intervention for Improving Homework Performance: A Critical Review', *School Psychology Quarterly 6*, 174-185

Ojedele P.K. (1992) *Influence of Parental Involvement on School Performance in Oyo State*. (Unpublished Ph.D. Thesis), Ibadan: University of Ibadan.

Okebukonla, P.A. O (1984) *Effects of Cooperative Competitive and Individualistic Laboratory Interaction Pattern on Students Performance in Biology*. (Unpublished Ph.D. Thesis), Ibadan: University of Ibadan

Okebukonla, P.A. (1985) The Relative Effectiveness of Cooperative and Competitive Interaction Techniques in Strengthening Student's Performance in Science Classes. *Science Education 69*, 501-509

Onocha, C.A. Okpala P.N. and Offorma, G. (1995) *Education of Women and Girls: Study of Equity in Eastern Nigeria*. A study Commissioned by the Regional Office of UNESCO/BREDA in AFRICA, Dakar, Senegal 101

Ross. J. (1998) Improving Social-environmental Studies Problem Solving Through Cooperative Learning. *American Educational Research Journal 25(4)* 573-691

Slavin, R. (1990) 'Cooperative Learning'. In C. Rogers and P. Kutnick (Ed). *The Social psychology of the Primary School*. London: Routledge, 226-246

The STS-Constructivist Reform: Some Discordant Notes

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Abstract

It would appear that as many more voices join in the advocacy for STS-constructivist Reform in science teaching/learning, more discordant notes are emitted. The purpose of the paper therefore, was to spotlight some of these discordant notes emitted in the course of the on-going reform advocacy. Specifically, three of such discordant notes bordering on focus, status, and initiation of the reform are identified. After a critical examination of the seemingly conflicting views on these issues, and drawing from relevant underlying theoretical constructs, more rational, realistic and sustainable viewpoints are synthesized.

Introduction

Polarization of views or dissension is not an uncommon feature of academic or intellectual debates. Indeed, knowledge growth has benefited immensely from such polarizations or dissensions, which sometimes manifest in competing schools of thought. The on-going STS-Constructivist dialogue ought not to be an exception. It is not to be expected that all will speak with a uniformity of voice on issues pertaining to the reform. Even among its protagonists or proponents, it will be a rare expectation, talk-less among its antagonists or opponents.

In a situation such as this, while the antagonists of the reform try to launch attacks at the propositions of the protagonists, the later will strive to debunk such criticisms or attacks. This process ignites a network of intellectual crossfire which will illuminate and brighten the whole terrain of the debate, particularly, the dark corners. This is positive and beneficial to scholarship.

Against this background, criticisms or *dissentions* coming from outside a given school of thought, are not necessarily discordant notes. However, if those who profess to belong to the same school of thought, send forth different and inconsistent signals to the intellectual community, or worse, still, if the positions maintained on certain issues are unclear and confusing then there is an ominous sign. Such inconsistencies or confusion arising from within – which in the context of this paper, have been referred to as discordant notes – can be fatalistic. The antagonists of the reform can

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capitalize on them to deal deadly blows on whatever structures we think we may have erected.

Purpose

In essence, the main thrust of this paper is to: (1) spotlight some of the discordant notes in the STS-Constructivist propositions; (2) examine these discordant notes critically; and (3) suggest what may be a more rationale, realistic and sustainable posture for the STS-Constructivist community with respect to the issues in question.

The discordant Notes

In this section, we shall examine these issues over which there appears to be considerable confusion or lack of clarity in the position of the advocates of STS-Constructivist reform. These are as follows:

1. What is the focus of STS-Constructivist pedagogy?
2. Current discussions of the STS-Constructivist reform tend to leave one in doubt as to the real focus of the reform. Four accounts of the reform which typify this situation are those of Lutz (1996), Myers (1996), Liu and Yager (1996) and Penick and Bonnestetter (1996) Lutz, in her account, gives the picture of a pedagogy which focuses only on process and not on product. According to her "an STS teaching strategy focuses on processes, not on products". (p.41).

Myers' account tends to agree in all essential details with Lutz's view. This is clearly born out of his assertion that "the STS approach – though not focusing on concept mastery – results in…" (p.56). Yet in another account, Liu and Yager opine that:

> The STS has been identified by the National Science teachers Association, Project 2061: Science for all Americans and with the NSTA/NSF Project: Scope, Sequence and Co-ordination (SS&C) as one with great potential for meeting the first three goal clusters advanced by project synthesis, namely, personal needs, social issues and career awareness (p.151).

In their own account, Penick and Bonnstetter (1996) posited that:

> STS teachers are not content with students just knowing words and skills; they insist that words be used to justify, defend, or clarify larger concepts or actions. For many students, they must apply their knowledge before it truly becomes a part of them. Effective STS teachers are never satisfied with content knowledge alone (p.169).

These four accounts are somewhat conflictual in what they present as the focus of STS-Constructivist pedagogy. The first two (Lutz and Meyers) tend to give the impression that STS-Constructivist pedagogy is not concerned with the development of content knowledge. They define a uni-dimensional focus (i.e., process only) for STS-Constructivist pedagogy. This does not only create an erroneous picture of the reform, it is indeed capable of drawing sharp criticisms from the antagonists of the reform (see Shamos, 1993).

The last two accounts (Liu and Yager, and Panick and Bonnstetter) give a better and more representative picture of the reform's focus. They correctly define a multi-dimensional focus for the reform in terms of the development of content knowledge, process skills, attitudes, applications and real-life

connections, etc. However, they still fall slightly short of providing a complete picture of STS-Constructivist focus.

For us, we see STS-Constructivist focus as extending to all the four goal clusters as identified in the Project Synthesis (Harms, 1977), namely: (1) personal needs; (2) societal needs: (3) career awareness/choice; and (4) preparation for further study. To limit the focus of the reform to only the first three clusters is to circumscribe the vision and projects of a reforms narrowly that has been described as "Mega Trend" and/or a "Paradigm Shift" (Yager, 1996:13). Indeed if "all reasonable projections agree on the universal penetrations of STS as K-12 and college-level approach to course structure and teaching approach throughout formal academia" as argued by Yager and Roy (1993:12), it becomes evident that the focus of the reform should and does extend to the fourth goal cluster-preparation for further academic study.

Alternatively, the focus of the reform can also be described more specifically in terms of the six (6) domains used in the Iowa Chautauqua Model – a model which has been widely used in initiating the STS-Constructivist pedagogy in the U.S. schools.

The six (6) domains essentially derive from the four goal clusters of Project synthesis. They include:

a) Concept Domain – Mastery of scientific content;
b) Process Domain – Acquiring science process skills;
c) Application and Connection Domain – Using the science concepts and process in new situation;
d) Creativity Domain – Improving in quantity and quality of questions, possible explanations, and predicted consequences;
e) Attitude – Developing more positive feelings concerning usefulness of science, science study, science teachers and careers;
f) World-View – Understanding of and ability to use basic science (i.e., questioning, explaining and testing objects and events) in the nature world.

A worthwhile program of STS-Constructivist pedagogy should focus on all these domains. No domain ought to be emphasized more or less than the other.

What is the status of STS-Constructivist Reform?

Another apparent conceptual crisis in the advocacy for STS-Constructivist reform has to do with its status. Is it a new science curriculum with a definite structure or what? This is one area that has been attacked vigorously by critics of the reform. For instance, Shamos (1998) calls this an identity crisis. According to him,

> STS has a serious identity problem….still it lacks a clearly defined structure on which to build such a curriculum; nor is to apparent that it will be possible to establish such a structure in the foreseeable future, because of the conflicting views that surround the STS movement (pp.66-67).

As a matter of fact, the STS-Constructivist approach could evolve into a curriculum as in the case of Science and Society (Lewis, 1981), and Science in Social Context (SISCON) (Solomon, 1983), both in the United Kingdom or PLON in the Netherlands (Eijkelhof, Boeker, Raat and Wijnbeek, 1981), and Science Plus in Canada (A ScP, 1986). However, the fear in holding this view of the STS-Constructivist reform is that it is bound to return as to the status quo. It may end up in students and their teachers relying absolutely on such a curriculum and this will defeat the raison deter for embarking on the reform. This is perhaps the strongest reason against the advocacy for a STS-Constructivist curriculum or textbook not that there is no structure for doing so as Shamos (1993) suggested.

There is also another reason why this is not necessary. There really have not been problems with the existing science content or topics per se. The problem has been with the mode of implementing such content. All the arguments against the traditional instructional setting science, border in the sterile and unproductive nature of the transmission mode adopted within such a setting (Nworgu, 1996, 1999) and not on the content being implemented. Therefore, it seems rational enough to use that the STS-Constructivist reform which emerged in response to the above specific concern, should have a clear mandate arising from its status as a new approach to implementing science instruction (Liu and Yager, 1996; Bonnstetter and Pedersen 1993). The characteristics of this approach and the goals it should accomplish have been elaborated and well delineated in Yager (1993 and 1996).

How should an STS-Constructivist lesson be initiated?

Another issue that needs to be addressed and clarified is how an STS-Constructivist lessons should be initiated. Certain accounts of how such lessons are initiated tend to generate some myth over the whole enterprise. Some of these accounts give the impression that STS-Constructivist lessons are initiated through "magical" or 'sudden' occurrences of a natural event or phenomena. The occurrence of such an event will then evoke a spontaneous reaction from the students. Others create a scenario where all the students arrive for a science lesson with a consensus view about what issues(s) or problem(s) to investigate. To drive home this point, we shall consider and analyze two of such accounts - one by Lutz (1996) and the other by Wilson and Livingston (1996).

Lutz's Account

> A ninth-grade chemistry class was being distracted by the particularly violent rainstorm going on outside the window. The teacher recognized the wisdom of allowing the students to watch the torrents….The students and the teacher gathered, talking at the rear of the room and watched the storm. One of the students asked about the acid content in the rain. Taking advantage of the students' natural curiosity (a fine example of "the teachable moment"), the teacher used this question to launch an STS investigation about the acid rain (p.46).

Wilson and Livingston's Account

> An example of focusing on science process skills was found in the ninth grade physical science program of City High (Iowa City, Iowa). The chemistry unit began with students

> looking at the chemicals found in products. Students were surprised at the amount of preservatives, flavor enhance's, and the claims advertised by the products. As the students investigated more and more products, their initial concern became amplified and the classroom took a student-centered direction. Their concern ultimately developed into the decision to initiate a full scale "Consumer Reports" investigation of various products (p.65).

These two accounts raise a number of fundamental concerns. First, should STS-Constructivist lessons wait until there is a fortuitous occurrence as in the case of the "particularly disturbing rainstorm? Second, if there hadn't been this "particularly disturbing rainstorm", does it mean that an STS-Constructivist teacher can not initiate instructions on acid rain? Third, suppose no student raised any questions at all, (and this does not have a remote possibility), would such an opportune moment (a teachable moment) go untapped? Forth, in the case of Wilson and Livingston's account, how did the products find their way into the learning environment? Fifth, how did it come to be that, all the students in the class got attracted to the same issue or problem - the chemical content of the products?

The two accounts in question and others similar to them, tend to give the impression that lessons in the STS-Constructivist setting have a spontaneous and/or mysterious beginning. They try to hide or conceal the teacher's role in initiating or facilitating the initiation of such lessons. This role is not direct or dictatorial; rather, it is facilitative and subtle but quite significant. It may be in the form of questions which will challenge the students to raise issues, ask questions or identify problems. It may be in the form of creating a stimulating and enabling environment which can challenge the curiosity and creative energies of the students.

We have chosen to refer to these facilitative and subtle but significant roles of the teacher in initiating an STS-Constructivist lesson as "teacher prompts". (compare this with the computer prompt). It is certain that the main focus of any STS-Constructivist lesson is on students personal activities which result in their construction of re-construction of scientific knowledge, in a context that shows clearly the usefulness of the new knowledge in solving personal and social problems using appropriate technology. Our contention is that the idea of an STS-Constructivist lesson being initiated via teacher prompts is more viable than the idea that it is initiated through spontaneous, sudden or 'mysterious' events. The later idea does not only diminish the significance of the teacher in the reform, it will result in a void with respect to the context of students activities. On the other hand, the idea of the "teacher prompt" creates the needed context for the students activities that will follow and does not in any way diminish the significance of either the student and his actions or the teacher in the STS-Constructivist setting.

Conclusion

There is no doubt that many more voices are joining in building a strong and persuasive advocacy for STS-Constructivist reform in science teaching and learning. The movement has become globalized. Research evidence from several sources is now available to convince anyone who cares that the

reform is both viable and feasible. Notwithstanding what may appear to be conflicting views within the advocacy itself, the antagonists of the reform even concede that it has obvious merits. It is certain that the reform has a multi-dimensional focus and a definite status as an innovative approach to science instruction/teaching. It guarantees the student a desirable level of autonomy necessary and sufficient for him to construct his own learning. For the teacher, his/her role is converted to an indirect but significant one. This is evident from the indispensable role teacher prompts are bound to play in the initiation of STS-Constructivist lessons.

Reference

Atlantic Science Curriculum Project (1986). *SciencePlus* I. Toronto: Harcourt Brace.

Bonnstetter, R.J. Pedersen, J.E. (1993). The Jurisprudential Inquiry Model for STS. In Yager, R.E. (ed). *What research says to the science teacher, Volume 7*. Washington, DC: National Science Teachers Association.

Eijelhof, H.M.C., Boeker, E.; Raat, J.H.; & Wijnbeek, N.J. (1981). *Physics in Society.* Amsterdam: VU-Bookshop.

Harms, N.C. (1977). Project Synthesis: An interpretative consolidations research identifying needs in natural science education. (A proposal prepared for the National Science Foundation). Boulder: University of Colorado.

Lewis,J. (1981). *Science and society*. London: Heinemann and Association for Science Education.

Liu, Chin-Tang & Yager, R.E. (1996). An STS approach accomplishes greater career awareness. In Yager, R.E. (ed.). *Science/Technology/Society as reform in science education*. Albany: State University of New York

Lutz, M. (1996). The congruency of the STS approach and constructivism. In Yager, R.E. (ed.) *Science/Technology/Society as reform in science education.* Albany: State University of New York.

Myers, L. (1996). *Mastery of Basic Concepts*. In Yager, R.E. (ed.). *Science/Technology/Society as reform in science education.* Albany: State University of New York.

Nworgu, B.G. (1996). *Teaching for Conceptual understanding in physics: A Conceptual Change Instructional Model*. A lead paper presented at the 37th Annual conference of the Science Teachers' Association of Nigeria at Uyo, 12-17 August.

Nworgu, B.G. (1999). *Post-positivistic developments: Challenges to contemporary STM teacher education*. A guest/special lecture to the First National Conference of the Faculty of Education, ENUGU State University of Science and Technology, 8-11 September.

Penick, J.E. & Bonnstetter, R.J. (1996). Different goals, different strategies: STS teachers must reflect them. In Yager, R.E. (ed.0

Science/Technology/Society as reform in science education. Albany: State University of New York.

Shamos, M.H. (1996). STS: A time for Caution. In Yager, R.E. (ed.*) What research says to the science teacher, volume 7.* Washington, DC: National Science Teachers Association.

Solomon, J. (1983). *Science in social content (SISCON*). United Kingdom: Basil Blackwell and Association for Science Education.

Wilson, J. & Livingston, S. (1996). Process skills enhancement in the STS Classroom. In Yager, R.E. (ed.) *Science/Technology/Society as reform in science education.* Albany: State University of New York

Yager, R. E. & Roy, R. (1993). STS: Most pervasive and most radical of reform approaches to science education. In Yager, R.E. (ed.) *What research says to the science teacher.* Washington, DC: National Science Teachers Association.

Yager, R.E. (1996). History of STS as reform in the United States. In Yager, R.E. (ed.) *Science/Technology/Society as reform in science education.* Albany: State University of New York.

Yager, R.E. (ed.) (1993). *What research says to the science teacher, volume 7.* Washington, DC: National Science Teachers Association

The Language Policy Practice in Mathematics Education in the Upper West Region of Ghana

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Abstract

Using Teacher's Assessment of Language Policy Practices (TAL2P) questionnaire and unstructured interview schedules, 63 randomly selected teachers (39 females, 24 males) from 21 schools within the Lawra District of the Upper West Region of Ghana were examined to determine the extent to which the language policy was practised. The study showed that teachers teach between 30-46% of their mathematics lesson periods in English at the lower primary level. Efforts to use the native language for meaningful mathematics instructions are constrained by teachers' inability to speak the language and the lack of materials in the native language. For children to derive the benefits of the language policy, the study recommends taking teachers linguistic competence into consideration during teacher postings and an urgent provision of text materials in the native languages to serve as resource materials for teachers.

Introduction

The issue of language policy for instruction, especially in developing countries, is a common problem that has attracted many researchers and policy makers since language policies have both micro and macro implications (Amoah, 2000; Broch-Utne,1997 and Bamgbose, 1984). A language policy can either provide or deny access to linguistic capital formation for different groups and individuals or national unity. It is in this respect that formulating and implementing language policies become a major concern among African countries.

Most African countries are multilingual with different language policies. For instance Namibia, according to Broch-Utne (1997), is a country with about 1.5 million inhabitants that has ten (10) Namibian languages as official languages of instruction in the first grades of schooling. This attempt to retain so many African Languages as languages of instruction is seen by linguists as a good initiative that should be appreciated internationally. This is because mother tongue acquisition is an important ingredient in the development of the child's intellect and other aspects of his or her personality. Also, in Zambia education is given entirely in the medium of English language whereas in Tanzania education is given entirely in the mother tongue (Osafehinti, and Nabie, 2001).

As a result of the multilingual nature of African countries many of them have sort to maintain bilingual instructional policies. They adopt a foreign language along side the native language as media of instruction. This is because instruction in the mother tongue is basic for people's existence and

identity and a decisive factor in the process of integrating and consolidating national unity.

The instructional value of a native language in African countries cannot be over stressed. Evaluation of studies that compare the native language and English language as medium of instruction for concept acquisition among children in Ghana (Collison, 1974), in Nigeria (Bamgbose, 1984; Adetula, 1990), and in Namibia (Brock-Utne, 1997) consistently showed that where English was used, majority of the children were not able to exercise their conceptual potential. In these studies, the performance of children was superior when problems were given in the mother tongue than in English. This shows the superiority of starting off instructions with the mother tongue, since "the local vernacular is a much more effective medium of instruction in the first two primary grades than English" (Bamgbose (1984: 95). This suggests that more use of the first language and less use of the second language seems to give better results. However, bilingual upbringing on pupils attainment in some countries have provided progress in certain schoolwork especially problem solving (McNamara 1967), Sharfuddin, 1984) cited in Osafehinti and Nabie (2001). Review studies show that, bilingual children may well be in advantageous position as compared to monolingual children (Austin and Howson, 1979). Bilingual education caters for children linguistic experiences and is often seen as a means of improving the educational attainment of indigenous children especially in developing countries. However, the general consensus based on research findings and experience is that the child suffers some kind of retardation as a result of partial linguistic mastery (Auerbach, 1993). Hence the need to ensure full mastery of the medium of instruction by pupils at the primary school if the language policy is to be beneficial to them.

It had earlier been observed that when a learner's linguistic experience are not catered for in the classroom, the learner finds himself at a crossroad not knowing what to do (Clarkson, 1991) cited in (Osafehinti and Nabie, 2001). A similar confusion was observed in a recent study in Ghana conducted by the Performance, Monitoring, and Evaluation (PME) Unit of the USAID in the Upper East Region on the achievement of primary 3 and 5 pupils in Mathematics and English. The study showed that when test items were read in English pupils could not write anything but when the items were read in the native language pupils were found busy working and writing down answers (Amoah, 2000). This further supports earlier findings' that children feel more comfortable learning in their own language.

Auerbach (1993) argues that, whiles there is no evidence that the exclusive use of English results in greater or more complete acquisition of knowledge, there is still significant evidence against its exclusive use in the classroom. Auerbach (1995) points out that, the exclusive use of English in the classroom results in non-participation, frustration and eventual dropout, and pupils' inability to build on existing native language literacy skills. The use of native language in teaching therefore serves as a natural bridge for pupils to overcome their learning problems and helps them to make rapid gains in the English language development.

While policy makers recognize the need to promote all mother tongues, there are several problems that militate against their implementation. Bamgbose (1976) points out that these language policies are not stated explicitly. The policies are often vaguely indicated with no rigid rules or laws as to which language or recommended texts to use. He contented that there is often inconsistency between policy and practice. So teachers tend to use any language freely in schools, especially in the rural areas. Besides, the educated elite who usually praises the virtues of education in the mother tongue often prefers local private schools or foreign countries where English and French are taught right from primary one that frequently abuses the policy. Consequently, the mother tongue or state language is not a popular choice among the students or the instructors even when made available.

Mathematics is an indispensable tool in the formation of an individual. It broadens and sharpens ones intellectual capabilities, and helps the individual to understand, interpret and to give accurate account of the physical phenomena observed in the environment. In this regard, it is important that mathematics is taught at all levels through the appropriate medium for better understanding. Children must be instructed in a language that they understand to enable them benefit from the subjects on which their future development rests. To lay a firm and consolidated foundation in mathematics, therefore, means using the appropriate medium of instruction for mathematics education. It is for this reason that in Ghana several attempts were made by the Christian Missionaries and ruling Government to enhance the development and use of indigenous languages for instruction. They all believe that instructional objectives can only be realised if learners are instructed in a language they can speak and understand very well (Andoh-Kumi, 1997). It is argued that when children are not instructed in the mother tongue at the lower primary, the school is depriving a part of the population from learning (Lind, 1995, cited in Brock-Utine, 1997)

Being aware of the role language plays in the intellectual development of the child, and the eminent consequences of using a particular Ghanaian Language as the official medium of instruction, Ghana has maintained a flexible bilingual policy for instruction. The official language policy stipulates that a Ghanaian language be used during the first three years of primary school education as the medium of instruction for all subjects whiles English remains a subject to be studied. After the first three years English becomes the medium of instruction and the Ghanaian languages then become subjects of study (Ghana Education Service - GES, 1988; ERRC. 1995). For teachers to be able to cope with the language policy of instruction at the lower primary level, initial teacher trainees are expected to study one other Ghanaian language other than their own (ERRC, 1995). The Teacher Education Unit (TEU) of the GES is therefore required to take teachers linguistic backgrounds into consideration during teacher postings to basic schools. However, there are many teachers in communities where the native languages spoken are 'foreign' to them and they can neither understand nor use the language for classroom instructions. Taking the nature of teacher postings into consideration, the study is therefore

designed to examine the extent to which the language policy, as it stands, is being practised at the lower primary level.

Research Questions

The study seeks to address the following questions:

(i) Are basic school teachers aware of the national language policy for instruction at the level they teach and what is their perception of the language policy?

(ii) What proportion of teachers is able to communicate in the native language during mathematics instruction?

(iii) What proportion of each instruction activity in mathematics reflects the use of the native language?

(iv) What problems militate against the implementation of the language policy for mathematics instruction?

Significance and scope of the study

Currently, there is agitation from various pressure groups in Ghana for a review of the language policy. The study on the language policy designed to determine the extent to which teachers are implementing the policy of instruction at the lower primary level could provide statistical data for the government on how the language policy is practised. The statistical evidence will could provide basis for the central government to rethink the universality of national language policy practice and a possible review or otherwise. In addition, child educators will become aware of the importance of language in classroom instruction and therefore plan to meet the linguistic needs of a heterogeneous classroom.

Although the problem of language policy for classroom instruction is a national issue, it is not possible for the study to cover the whole nation in view of the cost and the bulk of data that will be involved for a national study. Consequently, the study was restricted to teachers within the Lawra District of the Upper West Region of Ghana because it is one of the most deprived districts in the region that does not attract professional teachers.

Research Methodology

Population

The study covers lower primary school teachers within the Lawra district of the Upper West Region in Ghana. The district is located in the northwestern part of the region. Natives of this locality are predominantly subsistent farmers who speak Dagaare.

Sample

A random sample of 21 schools selected from the 52 primary schools within the district was used for the study. Names of the 52 schools were written on pieces of paper, which were folded and put in a box. The schools were picked at random from the box one at a time (with replacement) until the 21 schools were selected. This method was used to ensure that each school had an equal chance of being selected.

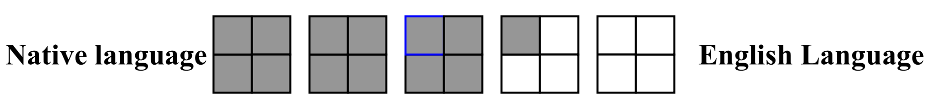
All the lower primary school teachers (that is, primary one to three teachers) in the selected schools were considered for the study. In all, 63 teachers out of 156 lower primary teachers in all the 52 primary schools within the district were involved in the study. The sample was made up of 39 female and 24 male teachers comprising 42 professional and 21 non-professionals.

Instrumentation

Two instruments, namely the modified form of Osafehinti and Nabie's (2001) Teacher's Assessment of Language Policy Practices (TAL2P) and unstructured interview schedules were used for the study. The TAL2P is a questionnaire made up of 3 sections (A, B, and C). Sections B and C of the TAL2P were modified to suit this study. This instrument, TAL2P, had exhibited an alpha coefficient of 0.91. Teachers were assured that their responses would be treated with utmost confidentiality and so they were open in their responses.

Section A of the instrument had 8 items designed to collect background information about the teachers. It also sought to find out the language of the locality, the native language of the teachers and the language that the teachers often use for classroom instructions. In addition, part of this section focused on the teacher's designation as to whether he/she is a head teacher, a class or subject teacher and the gender.

Section B was designed to estimate the proportion of the lesson period in teaching mathematics for which either the native language or English is used in the teaching process. In the (TAL2P), teachers were expected to shade any number out of the five squares arranged between native language and English language to reflect the proportion of lesson period in which either of the two languages was used. Each box represented 20% of the time of the lesson period. The modified TAL2P divided the squares in such a way that 5% of the lesson period for which either language is used could be indicated. For example a response in respect to the introduction of a lesson representing 65% use of native language may take the following pattern:



The last section, C, had ten items. The items were designed to find out whether the teacher studied Ghanaian Language at the training college, find out the problems teachers face in the use of the native language for mathematics instruction. In addition, they sought to find out how effective teachers are in the use of the local language, and whether there are available textbooks in the native language as guides. Teachers' views about the language Policy and their suggestions/impressions about the present state of the language policy were also sought.

The questionnaires were administered to teachers at their various schools. The teachers were given enough time to respond to them. The teachers were not allowed to take the questionnaire home to avoid others from influencing them, if they were allowed to do so.

Based on the responses, interviews were held with individual teachers to further elicit their expressed views. The pattern of the interview was determined by the nature of the responses provided. An enabling atmosphere was created for teachers to open up.

Analysis

Frequency counts on the number of teachers who are natives and had training in the use of the native language for instruction were determined. These were converted into percentages. Also, from the responses the proportion of lesson period in which the native language is used as medium of interaction in various aspects in teaching mathematics was computed.

Results

The instrument for the study on the language policy practice of basic school teachers, in general, sort information on teachers' linguistic background, what language they often use for classroom mathematics instruction, and their views about the language policy as it stands. The results of teachers' responses are presented in tables and figures.

Figure 1 shows the native languages of teachers who teach at the lower primary level in the schools under study.

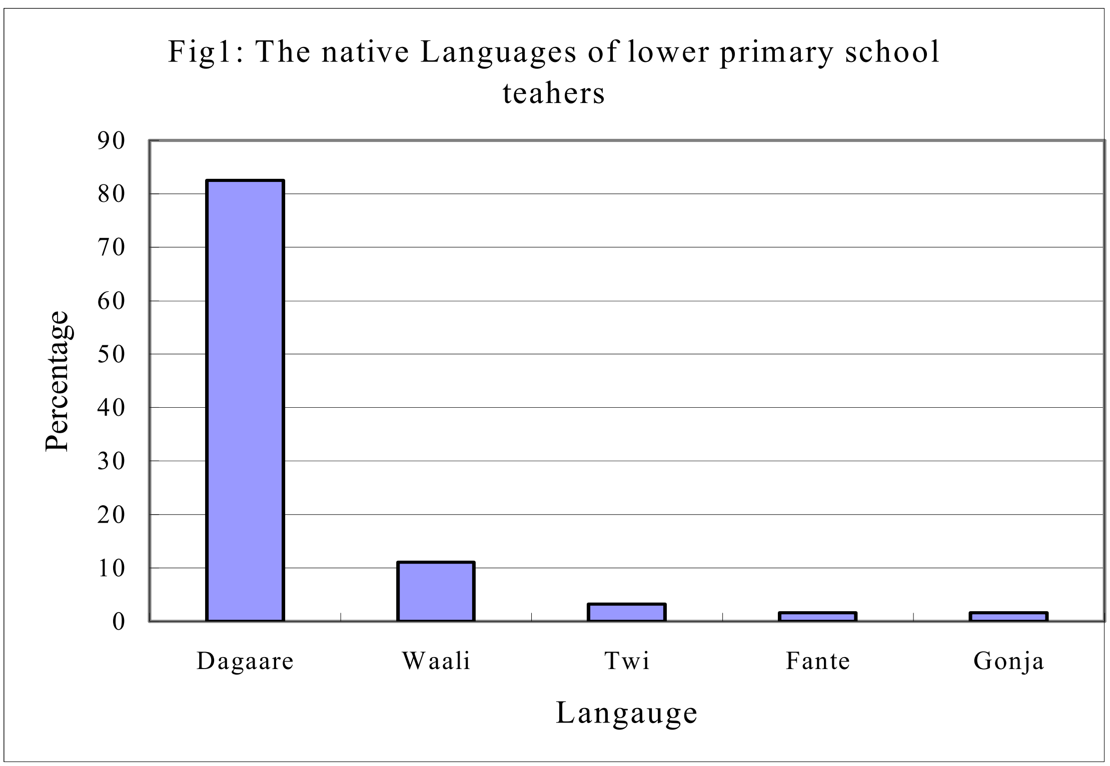


Figure 1 shows that 82.5% of the lower primary school teachers are speakers of the native language of the locality, Dagaare. Also, 11.1% of the teachers speak Waale, which is closely related to the native language of the locality. Evidently 6.4% of the teachers were non-speakers of the native language. The high percentage of teachers who are non-natives suggests

that most teachers can effectively communicate with the common language of instruction, Dagaare, the language spoken by the inhabitants of the school community. The non-native language speakers were interviewed. Asked why they opted to teach at the lower level when they could not communicate in the children's language, many of them claimed that the situation was above them. "There was nothing I could do since the upper primary was equally occupied" one responded. One newly trained teacher responded, "I was just posted there so I felt that was where my services were most needed". The female teachers among them however, responded that they had to join their husbands who were working in departments within the district.

Teachers' responses on the language they often use for mathematics instruction is as shown in Fig 2.

Fig 2 Teachers responses on their medium of instruction

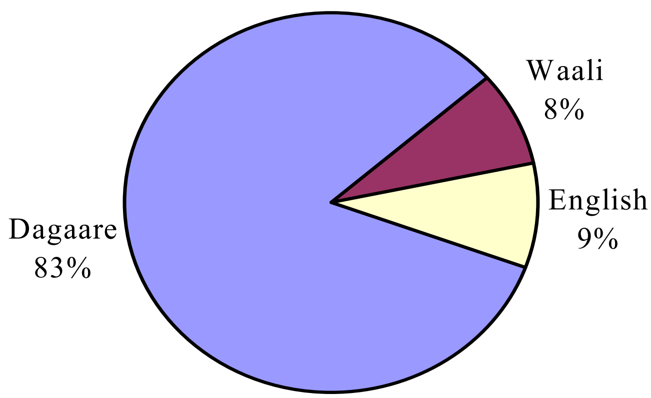


Fig. 2 shows that 83% of the teachers frequently used Dagaare, 8% used Waali and 9% used English for mathematics instruction. The high percentage of teachers in the area where they can communicate in the native language of the pupils is an indication of the implementation of the language policy for instruction.

Table 1 shows the mean percentage responses of teachers on certain aspects of policy implementation that can influence the language policy practice. Table 1 shows that a high proportion of teachers are aware of the language policy, (80.3%). Those who have control over the use of the native language for instruction constitute 72.9%. Also 64.4% of the teachers had studied the language during training. Unfortunately, many teachers (98.3%) indicated they have no guides to support them on the use of the language for instruction.

Table 1 Mean percentage responses of teachers on aspects and perception of the language policy practice

Variable	Percentage making Yes responses
Aspects of policy	
Awareness of the language policy for instruction	80.3
Teachers who study a Ghanaian language in college	64.4
Teachers with control over the use of the native language	72.9
Availability of Ghanaian Language guides for instruction	1.7
Teachers who face problems using the language	44.8
Perceptions	
The language policy is successful	76.8
The language policy needs modifications	55.4

The non-existence of textbooks and teacher's guides in the native language can make it difficult for teachers to find appropriate vocabulary in describing mathematical concepts. This probably explained why most teachers faced problems using the native language in teaching (55.2%). The majority of teachers (76%) see the language policy as successful while 55% of teachers are of the view that the policy be modified to ease some of the problems they faced.

The means of the proportions of aspects of instruction for which the native language was used for mathematic teaching process are shown in Table 2

Table 2 Means of proportions of aspects of instruction for which the native language is used

Aspects of Instruction	Percentage using Native Language	Percentage using English Language
Introduction of Lesson	61	39
Explaining a Point	62	38
Demonstration	61	39
Giving Instruction	60	40
Giving Exercise/Homework	59	41
Guiding Pupils in doing Exercises	54	46
Asking questions	58	42
Verbal Motivations	55	45
Guidance and Counseling	70	30

($\chi^2 = 26.552$; $p < 0.01$)

Table 2 shows that, in general, lower primary school teachers use both the native language and English for mathematics instruction. However, a chi-square analysis showed significant usage of the native language for

mathematics instruction compared to English language ($\chi 2 = 26.552$; $p < 0.01$).

Teachers use more than 53% of the native language but less than 71% in all aspects of the mathematics teaching process. The native language is used highest during guidance and counseling (70%) and least used when teachers are guiding pupils on their exercises (54%). The high use of the native language in Guidance and Counseling is probably because Guidance and Counseling services do not require the use of technical terms. Teachers' responses showed that the native language is equally used during the introduction of a lesson and demonstrations. They both show 61% use of the native language. In all the other aspects of lesson presentation, the use of the native language for instruction is still higher than the use of English language. Despite the higher proportion of the use of the native language in various aspects of instruction, teachers use an appreciable proportion of English in the various aspects of mathematics instruction. This situation is an indication of problems with the implementation of the language policy at the lower primary level.

Discussion and Conclusion

A language policy is operational when measures are put in place to ensure that it is practised. The results in figure 1 shows that many lower primary school teachers are speakers of the native language of the locality, Dagaare. This suggests that to some extent, efforts are made to ensure that language barrier that can have negative effect in classroom learning is eliminated or reduced. Mathematics instruction requires a unique form of communication. Children can become truly proficient in mathematics if they are able to understand and relate the mathematical ideas communicated to them.

The results show that a greater percentage of teachers often use the native language of the locality, Dagare, (83%) and 8% of the teachers use a closely related language, Waali, for mathematics instruction. This means that 91% of the teachers often use a native language that is quite understandable by both the teacher and pupils (see fig 2). This suggests that teachers are aware that the native language is a more efficient means of instruction (Bamgbose, 1984) and an important tool for the intellectual and personality development of the child (Legere, 1995). The fact that there is no communication barrier between pupils and teachers can be a source of motivation that will encourage children's participation in the learning process. However, 9% of lower primary school teachers who could neither speak the native language of the locality, Dagaare, nor the closely related language, Waali, use English language for mathematics instruction.

This exclusive use of English can result in non-participation, frustration (Auerback, 1995) and might probably be one of the reasons why some children tend to make choices against mathematics. This further suggests that children instructed exclusively in English language will often find themselves at crossroads not knowing what to do (Clarkson, 1991; Amoah, 2000). Children find themselves in such classroom situations because there are no rigid rules to enforce the policy (Bamgbose, 1976) and are merely learning by rote since the language barrier will be a hindrance for classroom

discussions through which mathematical ideas are shared, evaluated and amended (Nabie, 1997).

Responses given by non-native language speakers also suggest teacher postings, to some extent, do not take into consideration the linguistic competencies in the native languages. Rather, teacher postings are constrained by need and labour mobility.

Teachers' responses on statements that influence the implementation of the language policy for instruction, in general, suggest problems with the implementation process. Though about 64% percent of the teachers had studied Ghanaian language during training and about 77% of the teachers regard the current language policy as useful, about 55% recommended a modification of the policy and about 45% of those who use the native language have problems. Also, about 36% of the teachers, comprising some professional and non-professionals did not study Ghanaian language at all and some of those who studied Ghanaian language perhaps did so in other languages other than Dagaare or Waali. These teachers obviously will not be conversant with the dynamics of the language of the locality. A high proportion of the teachers (72.9%) have control over the use of the native language for mathematics instruction (see Table 1). However, they did not show exclusive use of the native language for instruction. Teachers instead used both the native language of the locality and English for mathematics instruction. Even though teachers often use the native language for mathematics instruction in all aspects of the instructional process (Table 2), the proportion of lesson period for which the native language is used is relatively lower than expected. This might be due to teachers' inability to obtain the native equivalent of mathematical terms. Both non-professionals and the professionals were substantially using English for instruction.

For the non-professional teachers, their situation would be quite understandable since they have no training on the use of native languages for classroom instruction. On the other hand, the inability of the professionals, especially those who can speak the native language of the locality, to exclusively use the native language suggests either poor preparation of teachers or it is not easy using the native language for mathematics instruction. The non-existence of text materials or guides for teachers to use for mathematics instruction (Table 1) means that teachers are likely to use their own terms which may have different meanings from the concept. The poor training of teachers on the use of native languages, problem of native equivalence of mathematical terms, and the total absence of materials can greatly impede the implementation of the language policy for mathematics instruction.

In general, the lesson period for which the native language is used for all aspects of mathematics instruction ranged from 54% in guiding pupils to do their exercises to 70% in providing pupils with guidance and counseling services. This means that teachers teach between 30% and 46% of lesson period in English at the lower primary level. Giving explanations, asking questions, and giving instructions, which one would expect, a higher use of the native language was less than expected. They recorded 62%, 58%, and 60% respectively. Children's understanding in aspects of mathematics

instruction would be limited as a result of limited usage of the native language. The unexpectedly high usage of English can be attributed to:

- the poor training of teachers on the use of native language for mathematics instruction
- the unprofessional status of some of the teachers
- the problem of language equivalence
- lack of materials
- some teachers who did not study the language of the locality, and
- disregard of teachers' linguistic competencies in native languages during teacher postings.

Teachers seem to be aware of the significance of the language policy on the mathematical development of children and try to practise it. They make effort to use the native language of the locality or a related language that children can understand for all aspects of mathematics instruction process. However, their efforts to use the native language for instruction are constrained by lack of materials in the native language to guide them. Some teachers are still posted to communities where they can neither speak the native languages nor understand them either because they had to join their working partners or out of need. In this circumstance, they are compelled to resort to the official national language. Children in their classrooms are most likely to find it difficult to understand the mathematical concepts. In addition, both trained and untrained teachers who even though could speak the language lacked the vocabulary and skills of using the native language as a medium for classroom mathematics instruction. Many lower primary school teachers therefore mostly combine both the native language and English for instructions because they lack the dynamics of using the native languages. The language policy for instruction therefore is not fully implemented for lack of direction from the policy makers. Appropriate mathematical register in a native language can have serious implications for mathematics instruction in the native language and would be an interesting area for further research.

Suggestions

The language a child speaks significantly contributes to his or her progress in mathematics education. To enable children derive the full benefits of the language policy for instruction at the lower primary school level, the following are recommended:

- posting of teachers to lower primary should take cognizance of the their linguistic ability;
- government should make conscientious effort to provide textbooks and guides on the natives languages with the appropriate mathematical register in these languages to serve as resource material for teachers;
- periodic training of teachers at the district level on the use of the native languages for mathematics instruction should be instituted and maintained;
- there should be vigorous supervision to enforce the implementation of the policy; and

- contraction of the Languages Departments in the Universities and Institutes to develop instructional materials in the native languages for use at lower primary.

References

Adetula, L. O. (1990). Language Factor: Does it Affect Children's Performance on Word Problems? *Educational Studies in Mathematics Vol. 21*.

Amoah, C. (2000). *Report of National Workshop on Improvement of Collection and Processing of Statistics Related to Youth and Adult Literacy in Ghana*.

Andoh-Kumi, K. (1997). *Language Education Policy in Ghana*. London: Longman, Green & Co.

Auerbach, E. R. (1995). The Politics of the ESL Classroom: Issues of Power in Pedagogical Choices. In J. W. Tollefson *Power and Inequality in Language Education*. Cambridge: Cambridge Univ. Press, 9-33

Auerbach, E. R. (1993). Re-examining English only in the ESL Classroom. Tesol Quarterly. *Educational Researcher. 25 (**5**).*

Austin J. L. and Howson, A. G. (1979). Language and Mathematics *Education. Educational Studies in Mathematics. 1 (**2**),* 161-197

Bamgbose, A. (1976) (ed.). Introduction: The Changing Role of the Mother Tongue in Education. In *Mother Tongue Education. The West African Experience*. London: Hodder and Stoughton, 9-26

Bamgbose, A. (1984). Enseignement en langue Matenelle et reussite scolaite au Nigeria, *Perspectives. Vol. XIV No 1,* 89-96

Brock-Utne, B. (1997). The language question in Namibian schools. *International Review of Education, 43 (**2/3**)*, 241-260.

Collison, G. O. (1974). Concept formation in a second language: A study of Ghanaian School Children. *Harvard Educational Review 44 (3), 441-457*

ERRC (1995). *Report of the Education Reform Review* Committee. MOE, Ghana.

G. E. S. (1988) *Mathematics Syllabus for Primary Schools*. CRDD, Accra.

Legere, K. (1995). Language in Namibian Education Achievements and Problems. Paper presented at the National Workshop on African Languages in Basic Education held at NIED in Okahandja from 18-22 September, 1995

Nabie, J. M. (1997). Children and Mathematical Investigations. *Ghana Educational Media and Technology Association Journal, 1 (1),* 17-26

Osafehinti, I. O. and Nabie M. J. (2001) A study of Language Policy Practice at Upper Primary School Level in *Ghana. Journal of Ghanaian Language Education. Vol. 1, 10-23*

Breaking the Mathematics Phobia of Secondary School Students Using Behaviour Modification Techniques

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Abstract

A unified approach to learning must specify what kinds of internal processes mediate the influences of diverse internal and external sources and must do so without abandoning crucial mentalistic concepts such as attention, curiosity, interest, motivation and meta-cognition. As our understanding progresses in this area, we may begin to comprehend how very young children can be so effective in learning their functional knowledge of the world and their mastery of school subjects. Teaching should be seen as an activity that is designed and performed for multiple objectives, in terms of changes in student behaviours. Students have multidimensional personalities having different learning styles. The common implication of these facts are that, the teachers should use different strategies of teaching, that is, matching the objectives of teaching and students' learning styles and personality dimensions, but the teacher education programme in Ghana, however, prepare the teachers for one or a few fixed ways of teaching such as the lecture method, the discovery method; inquiry method among others. It is in the light of the above that, this paper examines the use of behaviour method of teaching mathematics to alleviate the Mathematics Phobia among secondary school students.

Introduction

No Nation can attain any technological break through without well planned and effective implementation of a mathematics education, since mathematics plays a leading and service role in all aspects of human endeavour. Therefore, mathematics teaching and learning require a lot of space for demonstrations and self-learning activities to make an educated man. This was buttressed by Griffiths and Howson (1974:163), when they asserted that," the educated man is the knowledgeable man, trained to approach the affairs of his daily life with some sense of detachment and objectivity and to reason about them soberly and correctly".

Mathematics is the means of sharpening the individual's mind, shaping his reasoning ability and developing his personality, hence, its immense contribution to the general and basic education of the people of the world (Asiedu-Addo and Yidana, 2000). A mathematics teacher should therefore provide students with stimulating and wide-range of mathematical learning experiences that will develop their skills and knowledge. This will enable them function as useful citizens.

Howson and Wilson (1990) asserted that the teacher that lacks workspace cannot develop far as a reflective practitioner. This was buttressed by Franke and Carey (1997) when they commented that, the nature of the classroom environment in which mathematics is taught strongly influences how children perceive the subject, how it should be done and what they consider appropriate responses to mathematical questions. For example, a teacher who has to teach many classes a day has little time to reflect on his or her teaching and or prepare instructional materials for alternative approaches.

In a nutshell, sustainable development in nation building is essential and it is technological advancement of the masses that can lead to its realization in Ghana and in other developing countries. In Ghana, for example, mathematics is a compulsory subject in both the Basic school and senior secondary school curricula.

The compulsory nature of mathematics vis-à-vis the conception of the teacher of mathematics will also go a long way to demystify the phobia surrounding the teaching and learning of mathematics. This was buttressed by Thompson (1984:125) when he asserted that "the observed consistency between the teachers' professed conceptions of mathematics and the way they typically presented the content strongly suggest that the teachers' views, beliefs and preferences about mathematics do influence their instructional practices".

Behaviour Modification

The term "behaviour", according to Cormier and Hacknney (1993), includes covert or private events such as thoughts, beliefs and feelings (when they can be clearly specified), as well as overt events or behaviours that are observable by others. Developing adaptive behaviour often involves weakening or eliminating behaviours that work against the desired outcome therefore, adaptive behaviours help a person meet biological and social needs and avoid pain and discomfort (Wolpe, 1982). Behaviour modification is a reaction of a body to stimuli, playing down the role of the brain as a processor of information.

Behaviour modifications or interventions involve strategies that focus on skills, actions, habits and behavioural excesses and deficits. They are intended to help students to change their behaviour when that behaviour fails to support their goals, ambitions or values, or when that behaviour contributes to negative outcomes. Behaviour helping strategies utilize theories and processes of learning (Cormier and Hackney, 1993).

Although a large number of strategies can be classified as behaviour in nature and focus, perhaps the most common ones include social modelling approaches, skills training, operant conditioning, and contracting, relaxation training, systematic desensitization, covert conditioning and self-management techniques (Cormier and Cormier, 1985; Rimm and Masters; 1979). Behavioural approaches also share much in common with other

action oriented approaches to helping, such as reality therapy developed by Glasser (1965). Glasser and Zunin (1979) noted that, changes in behaviour that occur from reality therapy strategies also involved learning. They commented that " we are what we do, and to a great extent, we are what we learn to do, and our identity becomes the integration of all learned and unlearned behaviour.

Behavioural interventions share certain common elements with the following:

1. Maladaptive behaviour (that which produces undesirable personal or social consequences) is the result of learning, not illness, disease, or intrapsychic conflict.
2. Maladaptive behaviours can be weakened or eliminated, and adaptive behaviour can be strengthened or increased through the use of psychological principles, especially principles of learning that enjoy some degree of empirical support.
3. Behaviour (adaptive or maladaptive) occurs in specific situations and is functionally related to specific events that both precede and follow these situations. For example, a student may be aggressive in some situations, without being aggressive in other situations. Thus, behavioural practitioners attempt to avoid labeling students using arbitrary descriptors like "aggressive". Instead, emphasis must be placed on what a student does or does not do that is "aggressive" and what situational event precipitates the aggressive response, as well as events that strengthen or weaken the aggressive responses.
4. Clearly defined outline or treatment goals are important for the overall efficiency of these interventions and defined individually for each student. Thus, teachers must attempt to avoid projecting their desires for change onto students and also help students specify precise outcomes they want to make as a result of their teaching.
5. Helping interventions must focus on the present rather than the past or future and must be selected and adapted for each student on his or her set of problems and concerns. Behavioural approaches reject the "all purpose teaching" notion that assumes that, one method, or approach is generally appropriate for most students.

What is Phobia or Phobic Reaction?

Phobia refers to fear of an object or a particular situation that may be harmless. Phobic reactions are the acts exhibited as a result of an encounter with the fear arousing object or situation. Examples are anxiety, depression and stress.

Anxiety is a state of feeling nervous or worried that something bad is going to happen. For example, a person who suffers from anxiety neuroses has a fear or worry that has no basis. Such a person shows too much concern for his or her future to the extent that they are easily upset when the least mistakes are committed.

Depression is a condition where the person feels uncomfortable and unhappy. He or she may prefer to be alone and not mix in social

activities, he or she may not be able to concentrate on their studies. He or she feels a sense of unworthiness and questions his or her cause of living.

Stress means stimuli that are likely to produce disturbance in most individual. A stressful person may not be able to release tension adequately and this may lead to emotional disturbances.

Using Behaviour Modification Techniques in Teaching Mathematics

Skinner (1969) asserted that good teaching is the ability to arrange proper sequences of reinforcements for the students. Bruner (1966) also insists that, the final goal of teaching is to promote the "general understanding of the structure of a subject". That is, when the student understands the structure of a subject, he or she sees it as a related whole. "Grasping the structure of a subject is understanding it in a way that permits many other things to be related to it meaningfully". Bruner further stated that, when learning is based on a structure, it is more long-lasting and less easily forgotten. This is what Bruner calls a "*teacher prescriptive theory of instruction*", because it prescribes in advance how a given subject can best be taught. For example, if a learning theory tells us that, children at age six are not yet ready to understand the concept of reversibility, a theory of instruction would prescribe how best to lead the child towards this concept when he or she is old enough to understand it.

Teaching methods, according to Siddiqui and Khan, (1991), inevitably constitute significant aspects of the human effort to educate. These are, the patterns of teachers behaviour that recurrent applicable to various subject matters, characteristics of more than one teacher and relevant to learning and may be considered a sub-category of educational methods. This includes instructional devices such as teaching machines, conventional and programmed textbooks, simulations, films and others such as, inductive and deductive methods, heuristic method, lecture method, discussion method, discovery method, problem-solving method and project method among others.

Models of Teaching

Bruice and Marsha (1985) define models of teaching as a plan or pattern that can be used to shape curricula, to design instructional materials and to guide instruction in the classroom and other settings. The most important aim of any model of teaching is to improve the instructional effectiveness in an interactive atmosphere and to improve or shape the curriculum. Despite the insightful psychological and learning theories of Piaget (1958), Bruner (1966), Gagne (1970) and Skemp (1976) the learning of mathematics is still far from satisfaction. Begle and Gibb (1980) observed that while psychology has provided us with general theories of learning, we have not established general theory of learning mathematics to provide a basis for mathematics education. Researchers have revealed the under-achievement in mathematics by significantly large numbers of children in many countries [Husen (1967); Carpenter, Coburn, Reys and Wilson (1978); Cockcroft, (1982) and (Eshun, (1999)].

Therefore, the task for research in mathematics education is to provide information that would help "to understand better how, where, and why people learn or do not learn mathematics" (Begle and Gibb, 1980:8). However, the determinants that affect the learning of mathematics include; the learner's intellectual ability, maturity, learning style, emotional and social adjustment as well as attitudes.

People develop attitudinal behaviours towards mathematics just as they develop attitudes towards people, politics, religion, institutions and school subjects. Allport's (1935) definition of attitude implies that attitude is a state of an individual's mind that has resulted through experience and directs how that individual should respond to an object or situation that is related to or associated with it. On the other hand, Rokeach's (1972) definition implies that, attitude is the result of several beliefs a person hold that make him or her respond in a preferential way towards an object or situation. Staats' (1981) definition agrees in principle with Allport's (1935), that, attitude is not innate, it is a learned disposition and therefore could be changed and it permits response to things in some way. The objects or situations in all the above definitions may be mathematics itself, solving mathematics problems, understanding concepts in mathematics, usefulness of mathematics or motivation for learning mathematics. Therefore, attitude towards mathematics is a disposition towards an aspect of mathematics that has been acquired by and individual through his or her beliefs and experiences but which could be changed.

Howson and Wilson, (1990), points out that the teacher that lacks workspace cannot develop` far as "a reflective practitioner". This was buttressed by Franke and Carey (1997) when they asserted that the nature of the classroom environment in which mathematics is taught strongly influences how children perceive the subject, how it should be done and what they consider appropriate responses to mathematical question.

Mathematics anxiety manifests itself in persons who are uncomfortable in the world of representative samples and data analysis. Widmer and Chavez (1982) asked, What lies at the root of strong negative feelings about things mathematical?" The exact philosophy of causation may never be known, but several factors play a role. These factors include

a lack of preparedness,

b conditioning of associations, and

c expectations of teachers and students.

To avoid phobia among students as far as teaching mathematics is concerned, learning in the classroom should be transferable since transfer is the key to learning. Sprinthall and Sprinthall (1990) asserted that, transfer takes place when learning task "A" influences learning task "B". For example, teaching addition in mathematics before subtraction and division. Thus, when learning "A" facilitates learning "B", positive transfer is said to have taken place ;conversely, when learning "A" inhibits learning "B", negative transfer has occurred.

In view of the theories and the assertions by scholars as regards the breaking down of the myth surrounding the learning of mathematics among secondary students, Bruice and Marsha (1985) developed models of teaching to curb the phobia among students as far as mathematics teaching and learning in senior secondary schools is concerned. Bruice and Marsha (1985) organised the alternative models of teaching mathematics into four families, these are information processing, personal, social and behavioural. They stressed that the different instructional goals in mathematics would be realized by putting these models of teaching into action.

1 **Information Processing Family of Models of Teaching**

The models of teaching of this family are concerned with the organisation, presentation of verbal and non-verbal symbols in a way that helps in the formation of concept and solution problem and development of social relationship and integrated personality. Thus, these models are concerned with the productive thinking and development of general intellectual ability. The important models associated with this family are as follows.:

a Inductive Thinking Model of Hilda Taba: process the information through inductive "process".

b. Scientific Inquiry Model of Schwab: This model is designed to teach the method employed by the subject for solving scientific and social problems.

c. Concept Attainment Model of Bruner: This concept develops inductive reasoning that is, developing a concept after presenting its examples and non-examples.

d. Advance Organizer Model of David Ausubel: This model increases the capacity of learner to absorb and relate bodies of knowledge.

e. Cognitive Growth Model of Jean Piaget: This has been designed to increase general intellectual ability especially logical reasoning.

f. Memory Model of Herry Lorayne: This model is designed to increase the capacity to memorise concepts, facts among others (Siddiqui and Khan, 1991).

2 Personal (Family of) Models of Teaching

The models of this family is intended to develop the unique personality of the learner. These models pay more attention to the emotional life of the person and also focus on helping individuals to develop a productive relationship with their environment. Some of the important models of this family are as follows:

a. Non-Directive Teaching Model of Karl Rogers: This model aims at the development of the personal self in self-awareness, autonomy and self-concept.

b Synectics Model of William Gorden: This model is designed to develop creativity and creative problem solving in the learner.

c Classroom Meeting Model of William Glasser: The model aims at the development of a sense of responsibility and self–confidence in one's social group.

3 Social (Family of) Models of Teaching:

The models of this family are concerned with the social relationship of the individual with others in the society/classroom. These models aim at the development of social relationship, democratic processes and work productivity in the society. These models restrict themselves to the development of social relationship. They are also concerned with the development of mind, and the learning of academic subjects. Some important models of this family are as follows;

a. Group Investigation Model of Herbert Thelen and John Dewey: This model aims at the development of skills for participation in democratic social processes through interaction skills and inquiry skills.

b. Role Playing Model of Shaftel and Shaftel: It aims at motivating students to inquire into different personal and social values.

c. Social Simulation Model of Seren Boocock and Harold Guitzknow: This model is designed to help students to experience various social processes and to examine their own reaction to them and also acquire concept and decision making skills. (Siddiqui and Khan, 1991).

4. Behavioural (Family of) Models of Teaching:

The main thrust of these models is modification of the visible or overt behaviour, as well as the underlying psychological structure and unobservable behaviour of the learner. The main psychological bases of these models are stimulus control and reinforcement as put forward in B.F. Skinner's theory of operant conditioning and Bandura's theory of social learning. The common characteristic of these models are that, they break down the learning task into series of small sequences of behaviour. Each behaviour is so designed that success is ensured; the learner actively responds to the problematic situation and gets reinforcement and feedback. Some of the important models of this family are as follows:

a. Contingency Management Model of B.F. Skinner. This model proposes to teach facts, concepts, and skills to the learners by the teacher.

b. Self-Control Model of B.F. Skinner. It is designed to develop social behaviour and social skills among learners.

c. Stress Reduction Model of Rimm and Masters. This model aims at reduction of stress and anxiety in social situation and their substitution by relaxation among students.

d. Desensitization Model of Walpe. It is a model designed to reduce anxiety through pairing deep muscles relaxation with imaginative scenes that the student had said cause him or her to feel tense.

The above mentioned models under different aspects of human personality that is, the social, personal, informational and behavioural. Since education is meant for all round development of a child's personality, no single model can be selected for his or her development. Therefore, for effective teaching of mathematics in our senior secondary schools and its subsequent elimination of phobia among students, all the models will have to be employed according to the requirements of the situation, that is, if some

information is to be given, models of the first family would be required; if creativity is to be developed in the child, synectic model would be needed; if the objective is to eliminate anxiety and stress, desensitization model of Walpe would be needed, and if the objective is the development of the social skill, then model like Group Investigation Model of Herbert Thelen would be required (Siddiqui and Khan, 1991).

Furthermore, the selection of model also can be dependent on curriculum requirement, for example, a biology teacher may need the inductive model of Hilda Taba and Concept Attainment Model of Bruner, and social studies teacher who proposes to teach about values would need Role Play Model of Fannie Shaftel and George Shaftel, which motivates students to inquire into personal and social values.

However, some situations would require an application of a combination of models, that is, in a social studies class, the teacher may use Inductive Thinking Model to help children master map skills and Group Investigation Model for criticizing social issues.

As already mentioned, mathematics plays a leading service role in all aspects of human endeavour and ensuring a smooth mathematics education programme requires the formulation and implementation of appropriate instructional policies. For instance, a mathematics curriculum should therefore, provide children with stimulating and wide range of mathematical learning experiences that will develop their skills and knowledge. This will enable them function as useful citizens.

An intended mathematics curriculum should consist of a description of all the mathematical activities that children have to experience throughout their period of schooling to achieve certain objectives. This support earlier work of researchers such as Gibson 1969; Carmichael, Hogan and Walter, 1932; Zangwill, 1937; Krechevsky, 1938; Mowrer, 1947; Hebb, 1961) when they emphasized that perception is affected by past experience.

This fact, was also buttressed by Hebb (1961) when he asserted that, there is a behavioural evidence on the relationship between learning in infancy and that of the normal adult. Here, it is proposed that, the characteristics of the learning undergo forms of an important change as the animal grows; particularly in the higher mammals. That, all learning tends to utilize and build on any earlier learning instead of replacing it thus, much early learning tends to be permanent (Mowrer, 1947).

It is a truism that learning is often influenced by earlier learning experience since innumerable experiments have shown such a "transfer of training " that is, learning 'A' may be speeded up, hindered or qualitatively changed by having learned before, hence to eliminate phobia among students, mathematics teachers should encourage classroom discourse that is appropriately balanced between elicit, inform, direct and feedback exchanges and also use contexts that present real life experiences of the mathematical concepts and skills being taught (Mereku, 1995). This then, brings into focus the use of behavioural modification techniques in teaching mathematics.

References

Allport, G.W. (1935). "Attitudes". In C. Murchison (Ed). *A handbook of Social Psychology,* Worcester: Mass Clark University Press.

Aseidu-Addo, S.K. and Yidana I, (2000). "Mathematics Teachers Knowledge of the subject Content and the Methodology". *Journal of the Mathematical Association of Ghana, Volume 12,* University of Cape Coast. MAG Secretariat.

Begle, E.G. and Gibb, E.G. (1980), Why do research" *Research in Mathematics Education.* National Council of Teachers of Mathematics.

Bruner, J.S. (1966). Toward a Theory of Instruction. Cambridge, Massachusetts Belknap Press.

Cockcroft, W.H. (1982). Mathematics Counts. HMSO, London.

Chavez, A. and Wildmer, C. (1982). "Math Anxiety: Elementary Teachers Speak for Themselves". Educational Leadership (39:387-88).

Eshun, B.A. (1990). "*Sex - related Differences in Mathematics achievement of Secondary School Students*" - An Unpublished paper. University of Cape Coast.

Grifiths, A.H.B. and Howson, A.G. (1974). *Mathematics Society of Curricula.* London, Cambridge University Press.

Howson, G. and Wilson, B. (1990). 'School Mathematics in the 1990s' (A.G. Howson and J.P. Kahane eds). *ICMI Study Series,* Cambridge: Cambridge University Press.

Joyce, Bruice, and Weil Marsha, (1985). *"Models of Teaching*" New Delhi: Printice Hall limited.

Mereku, K. D. (1995). "*A Comparison of the official Primary Mathematics Curriculum in Ghana with the way in which it is implemented by teachers".* University of Leeds: School of Education (PhD. Dissertation).

Piaget, J. (1958). *The Growth of Logical Thinking from Childhood to Adolescence,* New York: Basic Books.

Siddiqui, M.H. and Khan, M.S. (1991). *Models of Teaching. (Theory and Research)* New Delhi: Ashish Publishing House.

Skemp, R.R. (1973). *The Psychology of Learning Mathematics.* Baltimore MD: Penguin Books Inc.

Skinner, B.F. (1969). "Why Teachers fail": *Educational Psychology,* New York, Van Nostrand - Reinhold. (164-172).

Sprinthall, N.A.and Sprinthall, R.C. (1990). *Educational Psychology - A Development Approach* (5th edition). USA: McGraw Hill, Incorporated.

Staats, (1981). *An Outline of an Integrated Learning Theory of Attitude.* New York Wiley.

The Fusion of Modern and Indigenous Science and Technology: How Should It Be Done?

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Abstract

Several African intellectuals, especially educators, have realized the need for the overhauling of Africa's educational systems to enable these intellectuals address the needs of Africans. In this paper, we have reechoed the need for this overhauling process, and have argued for an integration of indigenous knowledge systems with the formal school curriculum. In this paper, the benefits of integrating community science and technology with school science and technology and the constraints to the integration have been outlined. It also reports on the attempt at integration by the Centre for School and Community Science and Technology Studies (SACOST), at the University of Education, Winneba in Ghana. SACOST is a centre of excellence established by the African Forum for Children's Literary in Science (AFCLIST), a non-governmental organization. The paper identifies the community as having four major operating areas (the school, indigenous, informal and formal), each of which constitutes a group with shared interests, values and modes of operation. The model proposed for the integration focuses on the school as the central component that should utilize all the existing knowledge in the community in the human resource development.

Introduction

A diverse and growing body of opinion points to the need for an overhaul of Africa's public educational systems to address the needs of Africans (e.g. Brown-Acquaye, 2001; Noye, 2001; Erinosho, 2001). The overhauling of Africa's educational systems for sustainable development in this era, however, should hinge on the cultivation of a strong science and technology base. African countries, through various meetings and fora, have since independence endorsed science education as the wheel for meeting their needs and aspirations. It is believed that failure to recognize the role of the existing knowledge in the community in the promotion of science and technology education has adversely affected the development of a science culture in Africa. Forging links between community knowledge and Western science knowledge may hold the key to sustainable development of Africa. In this light, Brown-Acquaye (2000) asserts that "each is necessary and none is redundant". It is imperative to adopt a holistic approach at addressing our educational needs. The integration of every knowledge available (indigenous, informal and formal) in the community for an all embracing educational system that would cater for the needs of African societies is imperative. However, a number of constraints including old prejudices may have to be confronted in order to achieve maximum benefit

from the union. The object of this paper is to propose a model for the integration of school and community science and technology education for the effective teaching and learning of functional science in African schools.

Orientation of formal science education

The western science education introduced by colonial powers in African schools, colleges and universities sought to inculcate Western ideas in the colonized people. For example, the teaching-learning materials and syllabuses imposed on African countries were the exact replicas of those used in the metropolitan centres. Africans were also made to be consumers of the products of Western technologies. Indigenous Africans who behaved, dressed, spoke and acted like the white man were given the greatest honour, even by their fellow Africans. To promote this cultural assimilation policy, and at the same time maintain their dependence on outside inputs, structures needed for knowledge documentation and propagation and material production were not the priority of the African colonial lords, hence African countries had no opportunity to generate new knowledge or produce needed items themselves. This created a situation that compelled the colonized African countries to continue to depend on their colonial lords for science and technology, and their products. This outward orientation of western science education was also evident in the fact that its standards were set in metropolitan centres while its ultimate objective was to serve the needs of the colonial masters. Overseas postgraduate studies tended to, and continue to, be more in the interest of the host country since the content offered for study reflects the needs of the host country, and in many instances are not of immediate relevance to the needs of the developing world, including African countries.

In a nutshell, the Western science that is practised in our schools, polytechnics, universities and its application in the formal economy even though served to integrate African countries into the global knowledge system, it has brought about cultural alienation of the African people making them dependent on the values and belief systems of the West. This form of science, referred to as Western Science because of its historical origin, is viewed as a body of knowledge and ways of generating that knowledge about our world and ourselves. It is highly organized and hierarchically and chronologically structured and covers the science practised in research laboratories, institutions of learning and in industries and promoted by science subject associations and organizations.

A problem militating against the utilization of science for the common good of our nations is the restricted view of science as Western modern science or formal science thereby precluding the indigenous knowledge and know-how existing in our countries, which, to many science educators, constitute science. This view recognizes formal science as the only legitimate knowledge system that all societies should have. Thus, the education we received from the colonial masters led to the neglect of African culture, knowledge and values. This has developed to the extent that majority of graduates of the science programmes do not perceive the activities in their local communities and the time-tested knowledge of its practitioners as

anything worth paying attention to, a situation that has been described as cultural subversion (Peters, 2000) or cultural imperialism (Jegede, 1995).

Multicultural view of science

One of the current emerging paradigms in Science Education is the multicultural perspective of science where culture is seen as the norms, values, beliefs, expectations and conventional actions of a group (Phelan, Davidson and Cao, 1991; Aikenhead 1995). This trend is informed by the work of many researchers including Jegede and Okebukola (1990, 1991) whose findings provide compelling reasons for us to consider the implications of taking a multicultural perspective on science education on the continent. This perspective recognizes Western Science as a subculture of Western culture, and also as one of the many sciences of the world and not the only science. Each culture is deemed to have its own science, a system for adapting to its environment (Brown-Acquaye, 2001). Thus, one can talk about African science, Western science, Chinese science, Indian science and Japanese science. Within these broad classifications are subcultures such as schools, classrooms, industries and job, political, social, economic, and ethnic groupings and families, with their own knowledge and know-how, and therefore their own science. School science and its associated applications in industry are closely associated with the subcultures of western science.

The informal sector

Prominent among the other subcultures, in particular the subculture of African Science is the informal sector of a nation's economy. The informal sector may be broadly characterized as consisting of units engaged in the production of goods or services with the primary objective of generating employment and incomes to the persons concerned. These units typically operate at a low level of organization, with little or no division between labour and capital as factors of production and on a small scale. Labour relations - where they exist - are based mostly on casual employment, kinship or personal and social relations rather than contractual arrangement with formal guarantees.

The informal sector is made up of people who are identified by a set of knowledge, norms, beliefs, values, expectations and conventional actions and thus constitute a subculture with its own science, the informal science. Informal science as used here, refers to the corpus of knowledge, information and know-how practised in the informal sector of the economy and generally handed down through the apprenticeship system. The activities of the informal sector span over a wide spectrum including food production, food processing, tailoring, wood processing, metal fabrication and repairs, shoe making and repair, motor fitting and bodywork repairs, construction, repair services, handicrafts, pottery, trade, restaurants and transport operations. These activities are rich in science and technology ideas, concepts and principles. These activities, however, tend to be largely ignored, rarely supported, often regulated and sometimes actively discouraged.

We may note that informal science consists of three subcategories of science. Ogawa (1995) identified two of them, namely, personal science and indigenous science, where personal science refers to the preconceptions and science experiences of an individual. Indigenous science is the science knowledge of long resident people in a given culture. The practitioners continue to use time-honoured traditional (ancestral) practices. Examples are blacksmithing, kente weaving and pottery. The third level of informal science relates to the science knowledge of practitioners like motor fitters, vulcanizers, watch and radio repairers, as well as those using improved indigenous practices. The activities of these people are neither indigenous nor formal but seem to combine elements of both. This we wish to recognize as "way-side science" or "informal science proper". The practices and activities in "way-side" science relate in someway to conventional science practices. For example, the use of an electric milling machine makes traditional maize milling a wayside science.

Formal and informal science integration

Formal and informal sciences are not mutually exclusive, and can therefore reinforce one another. Each has its strengths and weaknesses, which can be capitalized on through the process of fusion. Western thought is often closed, by premises of intellectual superiority, to radical cross-cultural reflection (Peters, 2000). Yet we have reached a stage where science has to open its knowledge to other forms of knowledge. The multicultural perspective for science education recognizes conventional science teaching as an attempt at transmitting a scientific subculture to students and learning as the acquisition of a scientific subculture. There are, hence, the inherent border crossings between students' life world subcultures and the subcultures of science during science instruction. Using this metaphor of cultural border crossings, the African student has the problem of crossing from his/her informal science subcultures to the formal science subcultures. Since informal science is not part of the school curriculum, the student is left on his/her own to negotiate the borders of formal science. Dynamic links between the formal and informal science will reduce the trauma associated with border crossings and will also enable students to move in and out of the formal and informal science subcultures. Many science educators have called for the mainstreaming of informal science in formal science programmes (Yakubu, 1992; Anamuah-Mensah, 1998; Olorunmaiye, 1999).

Benefits to integration

Informal science activities can be used to illustrate and amplify science principles and theory and thereby help students gain a better understanding of formal science. For example, the porous earthenware pot used in storing water in rural homes can be used to illustrate evaporative cooling (an air conditioning process) and heat and mass transfer processes (Olorunmaiye, 1999). Using elements of the informal sector will also direct the minds of students to the materials and processes that are in their surroundings and, which most often are taken for granted instead of focusing on imported things, a role formal science has played very well. Giving recognition and equal status to informal science can lead to emancipator pedagogy.

Introducing informal science activities in the science curriculum can lead to the demystification of science and make science learning more exciting and relevant to the students and thus improve the culture of science of the populace. The school will not have to use the limited funds to purchase certain materials that can be readily obtained in the local environment. Integrating informal science knowledge into formal engineering programmes can contribute to the innovation of informal technologies (e.g. motor fitting, vegetable oil extraction, blacksmithing), upgrading of the practice, and transfer of technology, which can reduce the hazardous nature of the work involved, especially for women, and increase productivity for the operators who rely on these technologies for their livelihood. Such locally developed technologies will tend to be cheaper than imported ones. Apart from improving the production processes, the integration of informal and formal science knowledge can trigger a new dynamism in economic activities in the sector. Also, the study of local medicinal plants in the Departments of Pharmacy in our institutions of higher learning can help in adding value to the drugs and other medications produced by our indigenous medical practitioners (herbalists, fetish priests and priestesses), and lead to the production of new knowledge. It is noted that without the input of indigenous science many valuable medicines used today would not exist. By using indigenous knowledge of herbalists, bio-prospectors have the opportunity to increase the success rate in trials from one in 10,000 samples to one in two. It is estimated that indigenous knowledge increases the efficiency in screening plants for medicinal properties by more than 400% (Prakash, 2000). This type of development based on fusion of local knowledge of medicinal plants to conventional science in our universities is sustainable.

Another example is the infusion of management practices used by traditional farmers in the school agriculture curriculum to help prevent deforestation, soil erosion, drought and declining productivity, which result in famine in African countries. These management practices include agronomic practices such as terracing, contour bonding, fallowing, organic fertilizer applications, crop rotation and multi-cropping, indigenous soil and water conservation, soil fertility and indigenous soil taxonomies. It is clear that the integration of informal science and formal science has the potential of generating sustainable development. What obstacles are likely to prevent the incorporation of informal science in conventional science?

Constraints to informal/formal links

The effective integration of informal science into formal science can only be achieved with the removal of constraints that are inherent in the two subcultures of science. The constraints may be found in the differences between formal and informal science and the perceptions held by people, among which are:

- The perception of many scientists and science educators that formal science is universal, objective, authoritarian, value free, infallible and unchangeable.

- The perception that informal science is inferior and is full of superstitions and myths.
- Reluctance of authors and curriculum developers to include the contributions of informal science in science textbooks and syllabuses.
- The communication gap between practitioners of informal science and their counterparts among scientists and technologists.
- The secrecy associated with informal science practitioners.
- Informal science practices differing from one country to another. Each African country has a large number of these practices. However, these have not been studied.
- Lack of a science and technology policy framework that recognizes indigenous knowledge systems as science.

Attempt at integration

Since the traditional educational system in sub-Saharan African countries was supplanted by the colonial education system with its values, content and practices, no serious attempt has been made to bring back Africa's culture into the educational process. What is observed is the occasional spicing of the content of a lesson with specific local examples. A pan-African organization that has taken a bold step in this direction is the African Forum for Children's Literacy in Science and Technology (AFCLIST) based in South Africa, which has as one of its missions, the popularization of science and technology in Africa through the mainstreaming of indigenous science into formal science teaching. AFCLIST has set up a node of excellence, the Centre for School and Community Science and Technology Studies (SACOST), at the University of Education, Winneba, Ghana, and a sub node at the University of Swaziland to promote a dynamic integration between the two cultures of science. These centres encourage endogenous development of science through the integration of community knowledge and know-how with conventional science throughout sub-Saharan Africa. The centres are mandated to develop research competences in local people through post doctoral, graduate, undergraduate and individual research projects that relate to informal science knowledge, indigenous science knowledge and modern manufacturing knowledge. At the centres the findings are used to develop multimedia teaching/learning materials that ensure that the integration of formal science with other knowledge for use in school science teaching.

The Centre at Winneba, SACOST, has established permanent agreement with the National Board for Small Scale Industries (NBSSI) and the Ghana Regional Appropriate Technology Industrial Service (GRATIS) to develop materials for schools, and ensure that students have relevant hands-on experiences through attachments at the regional networks of Intermediate Technology Transfer Units (ITTUs) set up to help develop informal technologies in the country through training and improvement in the technologies. It is noteworthy that the concern for linking formal and

informal science and technology activities is not limited to Africa but cuts across other continents such as North America and Australia. For example, a groundbreaking step to mainstream informal science knowledge into formal science has been undertaken by the University College of Cape Breton in Nova Scotia, Canada, where a four year Bachelor of Science Community Studies (BScCS) has been instituted. This programme is intended to bring together the indigenous knowledge and know-how of aboriginal people, and the most current knowledge from the natural and cognitive sciences.

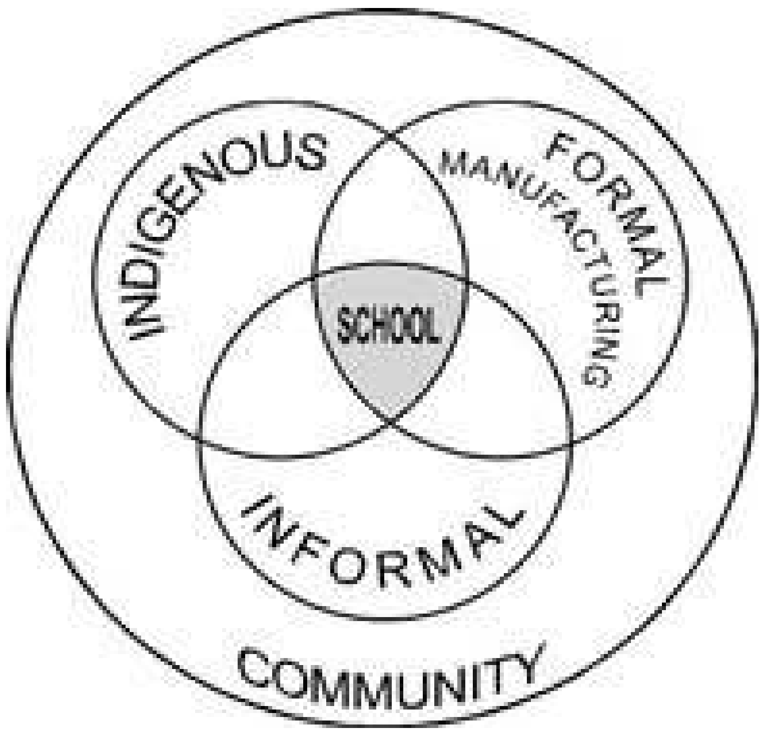

Fig. 1 Model of the relationship of indigenous, informal and formal economic activities on school science and technology education

Fig. 1 is a framework for bridging school and community science and technology. The community has four (4) major dimensions or operating areas each of which constitutes a group with shared interests, values and modes of operation. These can be seen in the Venn diagram in Fig. 1. These four (4) dimensions are school, indigenous, informal and formal. The figure focuses on the school as the central component in the model. This integration process is a triangular process involving indigenous, informal and formal within the community or larger socio-economic and cultural context. The indigenous, informal and formal economic activities constitute the workplace where there is practical application of science and technology. Thus indigenous science, informal science and formal science activities exist in the areas of the economy. It is recognized that the central component of the model, the school, has received much attention with studies done on classroom interactions among teachers, students and school environment. However, not much study has been done on the indigenous, informal and

formal economic activities. Studies on how the school impacts on the community and workplace, specially indigenous, informal and formal workplace activities have been negligible. Similarly the impact of the community activities on school science and technology education has received little attention. It is important to know how the different dimensions relate to each other in any one country and how this relationship can be used to bring about sustainable development. Three main modes of integration or relationship can be envisaged. These are the non-integrated mode, partially integrated mode and fully integrated mode.

The school is intertwined with the socio-political, economic and cultural context of the community. The subculture of the school is reconciled with societal sub cultures. For the model relation, there is a large overlap between the school and the three sectors making it possible for schools to accommodate indigenous, informal and formal science in their science and technology curriculum. Obviously, there is a two-way interaction between school science and technology and the Community Science and Technology that is found in informal sector, indigenous knowledge and formal manufacturing industries. There is communication among the 3 sectors and the school. There is continuity, and the different sectors influence each other. The formal manufacturing can interact and influence the informal and indigenous activities and improve on their performance and may eventually absorb some of them into the formal manufacturing system. The informal activities can in turn provide support for the formal sector through e.g. marketing products or producing items such as machine parts for formal manufacturing industries, and the provision of raw materials for some industries.

The schools need to respect the indigenous science and technology and informal activities and vice versa, each being aware of the difference among them. The different dimensions or subcultures should be perceived to be of equal value even though it is not being claimed that there will be an exact balance between them. It is believed that the burden of integration will be shared by all subcultures with the school taking the lead. One of the benefits of the integrated mode will be to enhance or facilitate the transition from school to work either in the informal or formal sector of the economy. Students in a programme that incorporates other dimensions will learn to operate in both the school and non-school cultures. They will recognize the strengths and weaknesses among the different cultures - school culture, informal, indigenous and formal cultures. This will enhance the utilization and transfer of concepts and strategies from one to the other, especially from the non-school dimensions (or workplace) the life world culture to the school curriculum. Such situation will allow for the cross fertilization of ideas and techniques that will help in the enrichment and improvement of the science and technology in the informal and indigenous sectors.

Conclusion

Many aspects of informal science knowledge have suffered serious erosion overtime because of the negative attitude that local people were made to develop towards it. However, current scientific knowledge recognizes the importance of indigenous knowledge in areas such as biodiversity,

agriculture and medicine. Modern scientific knowledge and traditional knowledge should be brought closer together in interdisciplinary project dealing with the links between culture, environment and development. Furthermore, modern science does not constitute the only form of knowledge, and that closer links need to be established between this and other forms, systems and approaches to knowledge, for their mutual enrichment and benefit. Traditional societies have nurtured and refined systems of knowledge of their own; they harbour information as yet unknown to modern science. A closer linkage between science and other knowledge systems is expected to bring important advantages to both sides (UNESCO, 2000).

The interface of formal and informal science can bring about sustainable developments and poverty alleviation. This points to the need to recognize informal and formal science as complementary rather than contradictory, even though there are fundamental differences. There is the need for commitment from governments to encourage an effective dialogue between scientists, technologists and informal science practitioners. A commitment is also needed from curriculum developers, university lecturers, teacher trainers and teachers to accept this new vision, and endeavour to bring about an effective interface of the two knowledge systems this may demand a more thorough study of the informal knowledge systems and the use of trans-disciplinary approach.

References

Aikenhead, G.S. (1995). *Towards a cross-cultural perspective on Western Students leaving Western science: Border crossings*. A paper presented at the annual meeting of the NARST, St. Louis

Anamuah-Mensah J. (1998). Native Science beliefs. *International Journal Science Education,* 20(1); *114-125.*

Brown-Acquaye, H.A. (2001). Each is necessary and none is redundant: The need for science in developing countries. *Science Education*, 85; 68 -70.

Erinosho, S. (2001). Providing link between indigenous/informal scientific knowledge and formal science: Implications for science teaching and learning. *In:*. J. Anamuah-Mensah, A. Asabere-Ameyaw and M. Savage (Eds) *Linking indigenous/informal science and technology to school science*. SACOST, Winneba.

Jegede, O.J. (1995). Collateral learning and the eco-cultural paradigm in science and mathematics education in Africa. *Studies in Science Education*, 25; 97-137

Jegede, O.J. and Okabukola, P.A. (1990). The relationship between African traditional cosmology and students' acquisition of a science process skill. *International Journal of Science Education*, 12; 37- 47.

Jegede, O.J. Okabukola, P.A. (1991). The effect of instruction on socio-cultural beliefs hindering the learning of science. *Journal of Research in science Teaching*, 28; 275 - 285.

Noye, D.A. (2001). A model for integrating informal science and technology into pre-university level educational system. *In* J. Anamuah-Mensah, A. Asabere-Ameyaw and M. Savage (Eds) *Linking indigenous/informal science and technology to school science*. SACOST, Winneba.

Ogawa, M. (1995). Science Education in a multiscience perspective. *Science education,* 79; 583 - 593.

Olorunmaiye, J.A. (1999). Applications of indigenous technologies to engineering Education. *Discov Innov., II (3/4);* 127 - 130.

Peters, M. (2000). Maori/Pakeha: Education and knowledge. *ACU Bulletin, 145*; 18 - 20.

Phelan, P., Davidson, A. and Cao, H. (1991). Students' multiple worlds: Negotiating the Boundaries of family, peer, and school cultures. *Anthropology and EducationQuarterly*, 22(2); 224 - 250.

Prakash, S. (2000). Indigenous knowledge and intellectual property rights. *IK Notes*, 19; 1 - 4.

UNESCO (2000). *World conference on science. Science for the 21st century: A new commitment.* UNESCO: Paris

Yakubu, J.M. (1992). Indigenous Science curriculum in Ghana. *Science Education International,* 3(3); 14 - 19.

Treatment Duration of Topics in Senior Secondary School Core Mathematics in Ghana: A Case Study of Cape Coast District

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Abstract

The purpose of the study was to investigate whether the intended time of 160 minutes per week for 96 weeks was adequate for the treatment of the SSS Core Mathematics. The study used simple random sampling method to select two mixed, two single-sex female and two single-sex male Senior Secondary Schools in the Cape Coast Education District of the Central Region of Ghana. The study involved 790 students. Three achievement tests in mathematics were used to collect data. The data were analyzed by means of student t-test. The results showed that the intended time of 160 minutes per week for 96 weeks for the SSS Core Mathematics Program was inadequate.

Introduction

A society's most valuable resource is its people and education is a process by which society invests in the development of its people (Pratt, 1980). Of the many resources committed to its investment, according to Pratt (1980), the most significant is time. Time is the one resource that is non-renewable, non-interchangeable and finite. By far the greatest amount of time that is used in schools is that spent by pupils, time that is committed not by their own consent but by order of their elders (Pratt, 1980).

Mathew (1989) shared the opinion that a pupil's level of attainment was directly related to the length of time actively spent on learning. Kraft (1994) also said that the amount of time spent on the basics of language and mathematics is a critical factor in the achievement level of students. Taylor and Richards (1985) gave two basic ways to allot time for the subjects in the curriculum. These two ways, they said were the allotment of time in unit lesson or period and the holistic time allotment. In allotment of time to the subjects, consideration should be given to the number of activities involved in the teaching and learning of the subjects. In other words, in allotting time to a particular subject, say mathematics, the topics to be treated within the syllabus were to be taken into account.

Many studies had revealed the high educational standards in mathematics in Japan (Greer and Mulhern, 1989). The first of these was the International Study of Achievement in mathematics carried out in the mid-1960s (Husen, 1967; Lynn, 1989). In this study, data were collected relating to achievement in mathematics of 13-year-olds and 18-year-olds from the United States, England, Australia and a number of nations in continental Europe (Lynn,

1980). According to Lynn (1989) the Japanese obtained the highest means in all the samples. Among the factors discussed was time spent on mathematics. According to Lynn (1989), Stigler, Lee and Steven (1987) found that Japanese and Chinese children spent much more time on learning mathematics than American children. For example, in the first grade, the number of hours per week spent on mathematics were 2.9 (US), 3.9 (Taiwan) and 6.0 (Japan). Again at the fifth grade the corresponding figures were 3.4 (US), 11.4 (Taiwan) and 7.6 (Japan) – (Stigler, Lee and Stevenson, 1987; Lynn, 1989).

Kraft (1994) had said the amount of time spent on the basics of language and mathematics is a critical factor in the achievement level of students. Though Kraft's (1994) study was focused on the primary education, it gives insight into time allocation and time use in our schools. According to Kraft (1994) while the length of primary school year in Ghana was 800 hours per year, it was 1080 hours, 1290 hours and 1128 hours per year in Benin, Burkina Faso and Nigeria respectively

(Kraft, (1994: 77). In the USA and Japan, the figures were respectively 1080 and 1440 hours per year (Kraft, (1994: 77). Again according to Kraft (1994) seven periods of 30 minutes each (210 minutes) were allotted for mathematics instructions at the primary level.

According to Anamuah-Mensah (1995), many research studies had demonstrated the effects of education on productivity. Citing UNESCO (1990), Anamuah-Mensah said that a recent study seemed to suggest an increase of one year in average years of education might lead to three-percent rise in Gross National Product (GNP), (Anamuah-Mensah, 1995; UNESCO, 1990). Mathews (1989) also said that research had confirmed that pupil's level of attainment was directly related to the length of time actively spent in learning. This was also confirmed by the International Assessment of Educational Progress (IAEP) project in 1991/92. According to the study, countries which scored above 70 percent on the achievement test were spending, on the average, more than 200 minutes (apart from Korea which was spending 179 minutes) on mathematics instructions a week (IAEP Report, (1992; 49). For example, China, which obtained the first position on the achievement test with a score of 80 percent, was spending an average weekly time of 307 minutes on mathematics (IAEP Report, (1992: 49).

The decision to change the general structure and content of education in Ghana dates as far back as 1973/74. The need for the change resulted from the recognition that any educational system should aim at serving the needs of the individual, society in which he lives and the country as whole. The report of the Committee set up to advise on the implementation of Junior Secondary School (JSS) Program (1986) indicated after reviewing the old education structure that, the first cycle was plagued with multiplicity of parallel programs, namely:

a. continuation school program,
b. middle school program and
c. junior secondary program.

Again some private schools were running a six-to-eight year course. The Committee observed that the parallel programs made it difficult to develop instructional materials and work out examination or evaluation procedures for these programs concurrently. The parallel programs also made it difficult to utilize scarce resources for the multiple programs. It was also realize that the existing structure of education was rather too long, and as such expensive. The content of education at both first and second cycles was devoid of practical skills that could equip students so that they could pursue different vocations. As remarked by Fafunwa (1967) and quoted by Bishop (1985):

> The syllabi of most of the subjects taught are replicas of English, French or Portuguese syllabi. Under such conditions the students that Africa will produce will be those who are African in blood but English, French or Portuguese in opinion, morals and intellect. Consequently they will tend to be "misfits" in their society. Unquestionably, wholesale curriculum reconstruction is well overdue in Africa and we mean that a radical change both in content and orientation is needed. (Bishop, (1985:241).

The new structure and content of education for Ghana, therefore, seeks to diversify education and introduce practical skills as early as possible at both the JSS and Senior Secondary School (SSS) levels. The JSS program began with the establishment of some Junior Secondary Schools on experimental basis in 1976, following the acceptance of Dzobo Report of 1974. Due to lack of both funds and political will, the new program could not be fully implemented until 1987. Prior to this period, public debates and fora were organized to collate views from the general public on the new education reforms (Education Reform Review Committee Report, 1994). Some Ghanaians expressed mixed feelings about the innovation. While others had their own reservations about the success of the reforms, others felt that there would be lowering of standards in our schools. Others also felt that the implementation process should have been done gradually or in phases instead of complete take off throughout the country. Others still felt that the three-year duration was short, compared with the former seven-year secondary education.

One group that had shown much concern about the duration of the SSS program was the Conference of Heads of Assisted Secondary Schools (CHASS). CHASS called for the review of the SSS program and suggested a change in the duration of the course from three to four years (Sam, 1992; Eminah, 1993).

Delivering a paper on the topic: "The Senior Secondary – A Forward Look" at the 32nd Annual Conference of CHASS, Professor D. A. Acheampong suggested that the SSS should be a four-year program. Again, delivering a lecture on the topic: "Crisis in Education" during John Mensah Sarbah memorial lectures on the 11th November 1997, Mr. K. B. Asante, a retired diplomat, suggested that the SSS program should be four years so that the products would benefit from university and other tertiary education (News Item of Radio Ghana at 6 a.m. on 12th November 1997; Daily Graphic of November 15th 1997). Recently University Teachers Association of Ghana (UTAG) also called for the extension of the SSS program from three to four

years to better equip the students for university education (Daily Graphic of September 15th 1998).

The release of the first result of the Senior Secondary School Certificate Examination (SSSCE) in 1993, sparked off adverse comments and criticisms from the public. The furor following the release of the results led to the formation of the Education Reform Review Committee (ERRC) in 1994 and was charged to look at the whole reform programme and make necessary recommendations for improvement. Among the recommendations the Committee made was that

> There should be a 6-3-4-4 structure of education. The number of years for the SSS program should be increased from three to four years, effectively increasing the number of years for pre-tertiary education from 12 to 13 (ERRC Report, 1994:14).

In the opinion of the Committee, in consideration of the philosophical and sociological basis of the educational reforms, the structure 6-3-4-4 is most cost-effective despite the increase in budget and also most equitable (ERRC Report, (1994:13). However, the Ministry of Education did not agree with the recommendation of ERRC that the structure of education should be 6-3-4-4, by increasing the duration of the SSS program from three to four years (Ministry of Education, 1994: 2).

The suggestion for the increment in the number of years of the SSS program from three to four by CHASS, ERRC, UTAG and other individual Ghanaians, pre-supposes that perhaps, the times allotted for the treatment of the various subjects in the SSS syllabi, including Core Mathematics, were inadequate. Time allotment in secondary schools before the inception of the SSS program in 1990 was 240 minutes a week for mathematics instructions. One would have expected the instructional time for the core subjects to be increased following the reduction of the number of core subjects from six to four (The Ministry of Education's views on the report of ERRC, October 1994). The time still remains 160 minutes a week for core mathematics instructions.

There seemed, therefore, to be a controversy on the intended time for the SSS program. While a section of Ghanaian community (example CHASS, ERRC, UTAG, etc.) felt that the intended time be increased, The Ministry of Education (and for that matter the government) insisted that it should remain the same. So far, there had not been any study to address this problem to empirically find out whether the intended time of 160 minutes per week for 96 weeks was adequate for the SSS Core Mathematics Program, apart from what Kwetey (1996) conducted in the Keta and Ketu Districts in the southern sector of the Volta Region of Ghana.

It appears research shows that there is an international consensus that school days and school years need to be lengthened in many countries in the world (Kraft, 1994). According to Kraft (1994), not only do Ghanaian children spend less time in school than many others, but that the actual 'academic learning time' is even less – in the area of two to three hours a day (Kraft, (1994: 17). A visit to some of the schools in the municipality by the researcher revealed that time allotted for mathematics instruction ranges between eight and ten periods of 30 minutes each (240 to 300 minutes) a

week in the Primary Schools, while at the JSS level the corresponding time allocation is between five and six periods of 35 minutes each (175 to 210 minutes) a week.

This study was, therefore, designed to investigate whether the intended average duration of 404 minutes per topic was adequate for the SSS Core Mathematics Programme.

Methodology

Population and Sample

The population was made up of all the students in the ten government assisted SS schools in the Cape Coast Education District. The sample was made up of all students in the three selected classes (one in SS1, one in SS2 and one in SS3) in each of the six randomly selected schools. These students were made up of 358 girls and 432 boys (790 in all), and were pursuing the General Arts Program who were moderate achievers in mathematics. The students had their ages ranging between 14 and 19 years.

Instrument

The instruments used were three achievement tests; one for SS1, one for SS2 and the other for SS3. Students were assumed to have understood the selected topics if two-thirds of each group obtained a minimum score of 40 percent in the achievement tests administered after the treatment (Bloom, (1971: 47); Pratt, (1985: 219).

The SS1 achievement test was made up of 10 items on all the sub-topics of the topic 'Algebraic Expressions'. The items were similar to the questions in the SS Mathematics Book 1, and it was made up of 60-minute written (essay) items. Each item carried six marks. Thus the maximum mark that could be obtained by a student was 60 and the least score was zero. For example item 5 on the SS1 achievement test reads:

Multiply $\frac{2a}{(a-b)^2}$ by $\frac{a-b}{a+b}$.

The SS2 achievement test was made up of five items covering all the sub-topics of the topic 'Statistics'. The items were similar to what were in the SS Mathematics Book 2, and it was a 60 minutes written (essay) paper. Each item carried 12 marks and items were based on the Year Two Statistics of the SS Mathematics Program. Thus a maximum of 60 marks could be obtained by a student, and the least score was zero. For example item e on the SS2 achievement test reads:

The ages, in years, of ten men are

42 28 40 33 31 32 52 45 37 40.

Calculate the standard deviation of the distribution.

The SS3 achievement test was also made up of five items similar to those in the SS Mathematics Book 3, and covered all the sub-topics of the topic 'Applications of Trigonometry'. For example item 2 on the SS3 achievement

test reads: 'A tree casts a shadow 9 meters long when the angle of elevation of the sun is 23°. How tall is the tree?'

Reliability

The achievement tests were pilot tested on the 100 girls from the two female schools involved in the study. These 100 girls were made up of 40 SS3 girls from one of the schools and 31 SS2 and 29 SS1 girls from the other school in the 1995/96 academic year who had been taught the selected topics. The two female schools are in the Cape Coast Education District and the 100 girls on whom the achievement tests were pilot tested were not involved in the main study. At the time of the pilot study, the SS3 girls from one of the schools were writing their mock examinations and this accounted for the inclusion of the 40 girls from the other school. Students' scripts were scored and the reliability coefficients were calculated using the Cronbach (1951) alpha formula. The reliability coefficients were found to be 0.84, 0.74 and 0.75 for the SS3, SS2 and SS1 achievement tests respectively.

Procedure

To find out how much time was needed for the treatment of the selected topics, the researcher conducted an experimental teaching in one class in SS1, one class in SS2 and one class in SS3 (all classes were pursuing the General Arts Program) of one of the females schools. This school was chosen for the experimental teaching because of the school's willingness to accept the researcher who was a former staff member. The classes were purposively selected after consultations with the Head of Mathematics Department of the school, who was also the Assistant Headmistress (Academic) for the school. Lesson notes on the selected topics were prepared and taught to students.

For the SS1 selected class, the experimental teaching was conducted daily between 27th February and 12th March 1997, all between 9.40 am and 11.00 am – treatment duration of 80 minutes daily for the period.

The experimental teaching for the SS2 class was conducted weekly in the afternoon between 4.00 and 5.20 from February 25th and March 10th 1997. Two more experimental teachings were conducted on April 29th and May 16th 1997(in the Second Term) all between 4.00 and 5.20 in the afternoon.

Four experimental lessons were conducted in the SS3 selected class, all in the afternoon, between 26th of February and 24th April, 1997. After two lessons, the whole exercise had to be postponed to second term because of the Schools and Colleges Sports Festival. The four experimental teachings were held on two consecutive days each week, - i.e. on 26th and 27th of February and again on 23rd and 24th April 1997, - all between 2.00 and 5.20 in the afternoon.

In consultation with the Heads of Mathematics Departments in the other selected schools, other experienced teachers were purposively selected to conduct similar experimental teachings in their respective schools. There were 15 teachers in all, made up of 10 graduates, two 'diplomates' and three specialists. These teachers had between six and twenty-six teaching experience. Records of instructional activities on the selected topics were photocopied and made available to the teachers. These instructional

activities were explained to the teachers to follow in order to ensure uniformity in all the selected schools. Teachers were asked to keep records of actual time spent on treating the selected topics in their respective classes. The researcher personally conducted the achievement tests in the selected schools after the experimental teaching by the teachers.

In order to cover more topics in the SSS Mathematics Syllabus, apart from the selected ones, the selected teachers were asked to keep records of the number of topics treated and the time spent on each treated topic for the term - second term of 1996/97 academic year.

Hypotheses

The following null hypotheses were formulated and tested, all at five percent significant level, as regards the problem at stake.

1. The actual mean time used in teaching the selected topics is not significantly higher than the average intended time allotted for the treatment of the SSS Core Mathematics.
2. There is no significant difference between the actual mean time used in teaching Algebraic Expressions and the average intended time allotted for treating the SS1 Core Mathematics.
3. There is no significant difference between the actual mean time used in teaching Statistics and the average intended time allotted for treating the SS2 Core Mathematics.
4. There is no significant difference between the actual mean time used in teaching Applications of Trigonometry and the average intended time allotted for treating the SS3 Core Mathematics.

Results

Table 1 below shows the actual times used by the researcher and the other teachers in teaching the selected topics.

Table 1 Times (minutes) spent in treating the selected topics.

School	**Time (minutes) spent**		
	SS1	SS2	SS3
A	720	400	320
B	520	480	400
C	1160	280	480
D	400	400	320
E	720	640	640
F	450	600	320

Table 2 shows the number of topics treated and the actual times spent by the teachers for second term in the 1996/97 academic year in the selected schools.

Table 2 Number of topics treated and the average times (minutes) spent for second term by teachers in the schools

School	Class	Number of Topics	Average Time
A. Wesley Girls' High School	SS1	8	513
	SS2	4	576
	SS3	5	352
B. Holy Child School	SS1	5	528
	SS2	7	274
	SS3	5	352
C. Mfantsipim School	SS1	7	617
	SS2	4	450
	SS3	4	360
D. St. Augustine's College	SS1	7	429
	SS2	7	329
	SS3	5	480
E. Aggrey Memorial School	SS1	4	500
	SS2	6	433
	SS3	4	600
F. Ghana National College	SS1	6	480
	SS2	5	528
	SS3	4	450

The computation of the Average Intended Times for the various forms were calculated with the formula $\frac{CW}{TC} \times T$

Where CW is Total Number of Contact Weeks; TC is Total Number of Topics Covered; T is the number of minutes used for the treatment of Mathematics per week.

The results obtained when the Average Intended Times for the various forms were calculated is presented in Table 3.

Table 3 Average Intended Times calculated for each class

Form	Minutes used for the treatment of Mathematics per week.
SS1	320
SS2	389
SS3	600
All	404

Tables 4 and 5 show the descriptive statistics of the time spent in teaching the selected topics and descriptive statistics of the time spent by the

teachers in the second term of 1996/97 academic year respectively. Tables 6 and 7 show the computation of t- statistic for the testing of the Hypotheses.

Table 4 Actual Mean Times and Standard Deviation

CLASS	N	MEAN	MEDIAN	TRMEAN	STDEV	SEMEAN	MIN	MAX	Q_1	Q_2
SS1	6	662.0	620	662.0	279.0	114.0	400	1160	438	830
SS2	6	446.7	440	466.7	135.4	55.3	280	640	370	610
SS3	6	413.3	360	413.3	128.2	52.3	320	640	320	520
	18	513.9	465	488.1	212.5	50.1	280	1160	380	

Table 5 Mean Times and standard deviations for second term

CLASS	N	MEAN	MEDIAN	TRMEAN	STDEV	SEMEAN	MIN	MAX	Q1	Q2
SS1	6	511.2	506.5	511.2	62.2	25.4	429	617	457.3	550.3
SS2	6	431.7	441.5	431.7	114.8	46.9	274	576	315.3	540.0
SS3	6	432.3	405.0	432.3	98.8	40.3	352	600	352.0	510.0
	18	458.4	465.0	460.0	96.7	22.8	274	617	358.0	528.0

Table 6 T-statistic for difference between Actual Mean Times with the Average Intended Times for first term

	N	MEAN	STDEV	SEMEAN	T	P-VALUE
SS1	6	661.667	278.741	113.796	3.00*	0.030*
SS2	6	466.667	135.450	55. 297	1.40	0.22
SS3	6	413. 333	128.167	52. 324	- 3.57*	0.016*
OVERALL	18	513. 88	212.468	50.079	2.19*	0.021*

* Significant at $p < 0.05$

Table 7 T-statistic for difference between Actual Mean Times with the Average Intended Times for second term

	N	MEAN	STDEV	SEMEAN	T	P-VALUE
SS1	6	511.167	62.185	25.387	7. 53*	0.0007*
SS2	6	431.667	114.760	46.851	0.91	0.40
SS3	6	432. 333	98. 828	40. 347	- 4.16*	0.0089*
OVERALL	18	458. 389	96.738	22. 801	2.39*	0.014*

* Significant at $p < 0.05$

Discussion

On the experimental teaching, actual mean time for the treatment of Algebraic Expressions in Year One was 662 minutes (about four weeks). That for Statistics in Year Two was 467 minutes (about three weeks). In Year Three, the actual mean time for the treatment of Applications of Trigonometry was 413 minutes (about three weeks). These figures were arrived at after considering all the actual times spent by the teachers who helped in the experimental teaching. It is interesting to note that in one of the SS3 classes, the teacher spent 320 minutes (two weeks) in treating the selected topic. After the conduct of the achievement test, only 23 percent of the students passed with a minimum mark of 40 percent. A further 160 minutes (one week) treatment of the topic in the class resulted in 70 percent pass, given the treatment time for the topic in the class to be 480 minutes (three weeks). In another class of another selected school, the treatment time of 480 minutes (three weeks) by another teacher resulted in 13 percent pass on the achievement test. A further 160 minutes (one week) treatment of the topic in the class by the teacher resulted in 68 percent pass in the achievement test.

These revelations appear to support Mathews' opinion that 'a pupil's level of attainment was directly related to the length of time actively spent on learning' (Mathew, 1989). This had also been confirmed by many research studies, examples of which were Stigler, Lee and Stevenson (1987) study in Japan, China and the USA; Lynn (1989) report of the study of achievement in Mathematics and Science among 12-year-olds commissioned by the Dallas Times Herald in 1983; and the international Assessment of Educational Progress Project carried out in 20 countries worldwide in 1990/91 (IAEP Report, 1992).

Data collected on the mathematics topics treated and the time spent on the topics by 18 teachers for the Second Term of 1996/97 Academic Year indicated that for the term;

- six topics, on the average, were treated in Year One,
- the average treatment time for Year One was 511 minutes ($3\frac{1}{5}$ weeks) per topic,
- six topics were averagely treated in Year Two,
- the average treatment time for Year Two was 432 minutes (about three weeks) per topic,
- on the average, five topics were treated in Year Three,
- the average treatment time for Year Three was 432 minutes (about three weeks) per topic,
- the overall average number of topics treated by the 18 teachers in the term as five,
- the overall average treatment time for the term was 458 minutes (about three weeks) per topic (see Table 2).

On the hypotheses, it was found that the actual mean time (514 minutes) for treating the SSS Core Mathematics was significantly higher than the average

intended time (404 minutes). This hypothesis was tested, using the student's t-statistic, at five percent level of significance [see Table 6). Again, there was significant difference between the actual mean time (662 minutes) and the average intended time (320 minutes) for treating the SS1 Core Mathematics. This hypothesis was consistent with Kwetey's (1996) study where the actual mean time was found to be more than the average intended time.

However, there was no significant difference between the actual mean time (467 minutes) and the average intended time (389 minutes) for treating the SS2 Core Mathematics. It was found that there was significant difference between the actual mean time (413 minutes) and the average intended time (600 minutes) for treating the SS3 Core Mathematics. In brief, while the null hypotheses 1, 2 and 4 were all rejected, hypothesis 3 was accepted, all at five percent level of significance.

Using the student's t-statistic to compare the average intended times with the actual mean times used by the 18 teachers in treating core mathematics topics for the Second Term of the 1996/97 Academic Year, it was found that the actual mean time for the term (458 minutes) was significantly higher than the average intended time (404 minutes). This test was done using five percent level of significance and t^* was 2.39 (> 1.740 - t value from Tables) while P-Value was 0.014 (< 0.05). In SS1, the term's mean treatment time (511 minutes) was also significantly different from the average intended time (320 minutes). The t^* value was 7.53 (> 2.571 - t value from Tables) and p-value was also 0.0007 (< 0.05). In SS3, the $|t^*|$value was 4.16 (> 2.571) while p-value was also 0.0089 (< 0.05). This shows that the term's actual mean treatment time (432 minutes) for SS3 Core Mathematics was significantly different from its corresponding average intended time (600 minutes).

For the term, again it was in SS2 that there was no significant difference between the term's actual mean treatment time (432 minutes) and its corresponding average intended time (389 minutes). This time, the t^* value was 0.91 (< 2.571) and p-value was also 0.40 (>0.05) [see Table 7].

It was interesting to note that the actual mean times for treating the selected topics in the various forms were all significantly different from their corresponding average intended times except in SS2. This, in part, implied full utilization of teacher-student contact hours was not realized in SS1 and SS3.

In SS1, students report to school in the first term long after re-opening. For example in 1996/97 Academic Year, when the data collection was carried out, SS1 students reported to school, in the first term, in the fourth week of re-opening of schools. These students further underwent orientation exercises before starting academic work. In some of the selected schools, before the students settled for any meaningful academic to begin, the term was almost ended. Thus in such schools no meaningful utilization of teacher-student contact hours was achieved in the first term. Besides this late arrival of these students, it is in Year One that a lot of mathematics

topics are supposed to be treated – 16 topics as compared to 14 in SS2 and 8 in SS3 SSS Core Mathematics Syllabus).

In SS3, again students complete their final examinations (SSSCE) before the end of the end of the academic year. This also denies the students the benefits of the full teacher-student contact hours. One needs to mention also series of activities like inter-schools sports and others that take students off the classroom. The research, therefore, welcomes the Ministry of Education's decision to change the Academic Calendar for Senior Secondary Schools from December-January to August-September (Daily Graphic, November 10th 1997, p.1 col.3-4).

It should also be noted that all the schools involved in the study were Grade A as well as urban. One can, therefore, envisage the situation in other schools, especially in the rural SS schools.

Comparison of the Situation in Ghana with that of other Countries

Table 8 shows the disparities in the average days of instructions, average minutes of instructions and average minutes of mathematics instruction in Ghana and other countries.

Table 8 Disparities in Treatment Duration of Mathematics in some Countries.

Country	Average Days of Instruction in Year	Average Minutes of Instruction Each Day	Average Minutes of Mathematics Instruction in School Each Week
Brazil	181	271	205
Canada	188	304	225
China	251	305	307
England	192	380	190
France	174	370	230
Ghana*	200	320	160
Israel	215	278	205
Mozambique	193	272	217
Soviet Union	198	243	258
United States	178	338	228

Source: The International Assessment of Educational Progress Report, 1992 (Ghana excluded)

It is evidently clear from Table 7 above that, of all the countries, it was Ghana that had the least amount of instructional time (160 minutes per week) for mathematics. Mozambique, an African country like Ghana, even had 217 minutes for mathematics instruction per week, though she obtained the least position on the achievement test with a score of 28 percent (IAEP Report, (1992: 49).

The disparity becomes even more glaring when compared with the situations in some of the advanced countries like Canada and the United States. While Ghana's time was 160 minutes per week, Canada and the United States had respectively 225 minutes and 228 minutes per week for mathematics

instructions. China, which obtained the first position on the achievement test with a score of 80 percent, was allotting 307 minutes per week for mathematics instructions (IAEP Report, (1992: 49).

A look at the table again depicts that while Ghana allots an average time of 1600 minutes per week (320 minutes per day) for teaching instructions, only 160 minutes (only 10 percent) is allotted to the teaching of mathematics. This could be compared with the situation in Mozambique, an African country involved in the IAEP Study, where out of an average time of 1360 minutes per week (272 minutes per day) allotted to teaching, 217 minutes (16 percent) was for teaching of mathematics (IAEP Report, 1992).

This inadequacy of treatment time for mathematics had compelled all the schools to adopt new teaching timetables in order to have more treatment time for the subjects taught in the schools. While some of the schools still maintain 160 minutes, others allot 200 minutes. Furthermore, while others allot 210 minutes some devote 240 minutes per week for the treatment of mathematics.

The teaching and learning of mathematics depend greatly on the teacher's competence in the subject. It is obvious that mathematics teachers should be abreast with current trends in mathematics teaching and learning. Mathematics classes should be made more interesting, practical and relevant to everyday activities. The Ghana Education Service (GES), as a matter of urgency should see to the organization of periodic in-service training for mathematics teachers in the short run. In the long run, training of more mathematics teachers should be emphasized as the study showed that some of the teachers teaching mathematics in the selected schools were not major-trained mathematics teachers. For example in one of the selected schools it was found that a teacher who majored in Visual Art was teaching both Visual Art and Mathematics.

The GES should again see to the writing of relevant mathematics textbooks, which are urgently needed in the schools. Agencies as well as individuals should be encouraged in this direction. This is a challenge to the Mathematical Association of Ghana (MAG) as well as the Curriculum Research and Development Division (CRDD) of the GES.

GES should come out with a unified number of periods for the various subjects in the SS curricula including mathematics. This might help to put a stop to the present situation where schools had allotted different time periods for mathematics instructions on the schools' timetables. For instance, while some schools had allotted six periods of 40 minutes a week, others had allotted five periods of 40 minutes a week. Others are still using four periods of 40 minutes a week, and still others are using different time periods for different forms in the same school. The researcher suggests six (6) periods of 40 minutes a week (240 minutes a week) for the treatment of Mathematics (Core) at the SSS level.

Results from the hypotheses indicated that, in SS1, the actual mean time was more than the average intended time for treating the SS1 Core Mathematics. Again in SS3, the actual mean time was less than the average intended time for the treatment of the SS3 Core Mathematics. This means

that while the SS1 students have less time to do more work, the SS3 students have more work to do relatively less work in Core Mathematics. The researcher, therefore, suggests that some topics in SS1 could be delayed till SS2 and some topics in SS2 could be delayed till SS3 so that there may be fair distribution of the topics in the SS Core Mathematics in the three levels instead of the current 16, 14 and 8 topics in the respective levels.

According to Kraft (1994), research from other countries indicates that one-fourth (1/4) of the time in school is actual 'academic learning time'. In Ghana, research indicates that, due to tardiness, student and teacher absence, lack of instructional materials and a range of interruptions, the actual time given to English and Mathematics is even more severely limited (Kraft, (1994: 18). Kraft (1994), goes on to suggest that teachers need to be taught a host of strategies to make better use of time allotted to schooling. School Heads need to supervise classroom time use, not to talk about absenteeism of teachers and students. In addition, cutting down on interruptions (holidays), starting school on time, not ending early, and not having long breaks would all add to instructional time (Kraft, (1994: 78).

References

Abbiw, M. K. et al (1991). *Ghana Senior Secondary School Mathematics Books 1, 2 & 3* Oxford: International Education Unit of Oxford University Press.

Ablekpe, B. (1997). 'Academic Calendar to Change for SSS', *Daily Graphic, 10* November, 1997, Front Page.

Acheampong, D. A. (1994). "*The Senior Secondary – A Forward Look".* A paper delivered at the32nd Annual Conference of Heads of Assisted Secondary Schools (CHASS) at Archbishop Porter Girls Secondary School, Takoradi.

Adjei, A. N. (1997). "The Mensah Sarbah Lectures their significance". *Daily Graphic, 15* November, 1997, p. 9.

Anamuah-Mensah, J. (1995). "The race Against Underdevelopment: A Mirage or Reality, *The Journal of Science and Mathematics Education. Vol.1 No.1* p.1

CHASS, (1994), *Minutes of the First National Executive Meeting held at Accra Girls' Secondary School*, Accra.

GHANA ,Ministry of Education, (1986). *Report of the Committee set up to advise on the Implementation of Junior Secondary School Program*. Accra: State Publishing Corporation.

GHANA, Ministry of Education, (1974). *The New Structure and Content of Education for Ghana.* Accra: State Publishing Corporation.

GHANA, Ministry of Education, (1994). *Report of the Education Reform Review Committee.* Accra: State Publishing Corporation.

GHANA, Ministry of Education, (1994). The Ministry of Education's Views on The Report of The Education Reform Review Committee (ERRC). Accra.

GHANA, Ministry of Education, (Undated). Guidelines For The Implementation of Improved School Education Reforms Program. Accra.

Greer, B. and Mulhern, G. (1989). *New Directions in Mathematics Education*. Wiltshire: Anthony Rowe Ltd., Chippenham.

Harnisch, D. L. et al (1985). 'Mathematics productivity in Japan and Illinois' Evaluation in Education, *An International Review Series 9*; 277 – 84.

Hovarth, P. J. (1987). 'A Look at The Second International Mathematics Study Results In the USA and Japan', *Mathematics Teacher 80*: 359 – 68.

Husen, T. (1967). *International Study of Achievement in Mathematics: A Comparison of Twelve Countries*. Stockholm: Almquist and Wiksel.

IAEP, (1992). *Educational Testing Service. Learning Mathematics: The International Assessment of Educational Progress.* New Jersey: USA.

Kodzo-Akyire, N. (1998). "Is there a crisis in Education?" *Daily Graphic, 15* November p.9 Col. 1 – 5.

Kofoya-Tetteh, A. (1998). "Extend SSS Program to Four Years - UTAG". *Daily Graphic, 15* September p. 1.

Kraft, R. (1994). *Teaching and Learning in Ghana; A Curriculum, Textbooks, Syllabus and Handbook Analysis*. A Report submitted to the Agency for International Development USAID mission in Accra, Ghana.

Kwetey, A. A. D. (1996). *Treatment Duration of Some selected Topics in The Senior Secondary School Core Mathematics Syllabus*. A Long Essay presented The Department of Science Education, Faculty of Education, University of Cape Coast, Cape Coast.

Lynn, R. (1989). 'Mathematics Teaching in Japan' in Brian Greer and Gerry Mulhern (ed.) *New Directions in Mathematics Education,* (1989), Wiltshire: Anthony Rowe Ltd. Chippenham.

Mathew's, J. (1989). *Curriculum Exposed*, London: David Fulton Publishers Ltd.

Mort, P. R. (1964). 'Studies in Educational Innovation' in M. B. Miles (ed.) *Innovation in Education*, Columbia: Teachers' College, New York.

Oldham, E. (1989). 'Is there an International Mathematics Curriculum?' in Brian Greer and Gerry Mulhern (ed.) *New Directions in Mathematics Education,* (1989), Wiltshire: Anthony Rowe Ltd. Chippenham, Great Britain.

Oliver, A. (1965). *Curriculum Improvement; A Guide to Problems, Principles and Procedures*, New York: Dodd Mead and Company Inc.

Pratt, D. (1980). *Curriculum Design and Development*, New York: Harcourt Brace Jovanouich Publishers

Spiegel, M. R. (1992). *Schaum's Outline of Theory and Problems of Statistics*. (2nd Edition) McGraw-Hill International, United Kingdom.

Stigler, J. W. Lee, S. Y. and Stevenson, H. W. (1987). 'Mathematics Classrooms in Japan, Taiwan and the United States',. *Child Development 58:* 1272 – 85.

UNESCO, (1975). *The Experimental World Literacy Program; A Critical Assessment*, Paris: France.

UNESCO, (1990). *World Conference on Education For All; World Declaration on Education for All and Framework for Action to meet Basic Learning Needs*, Paris: France.

Curriculum, quantitative concepts and methodology of teaching children with learning difficulties

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Abstract

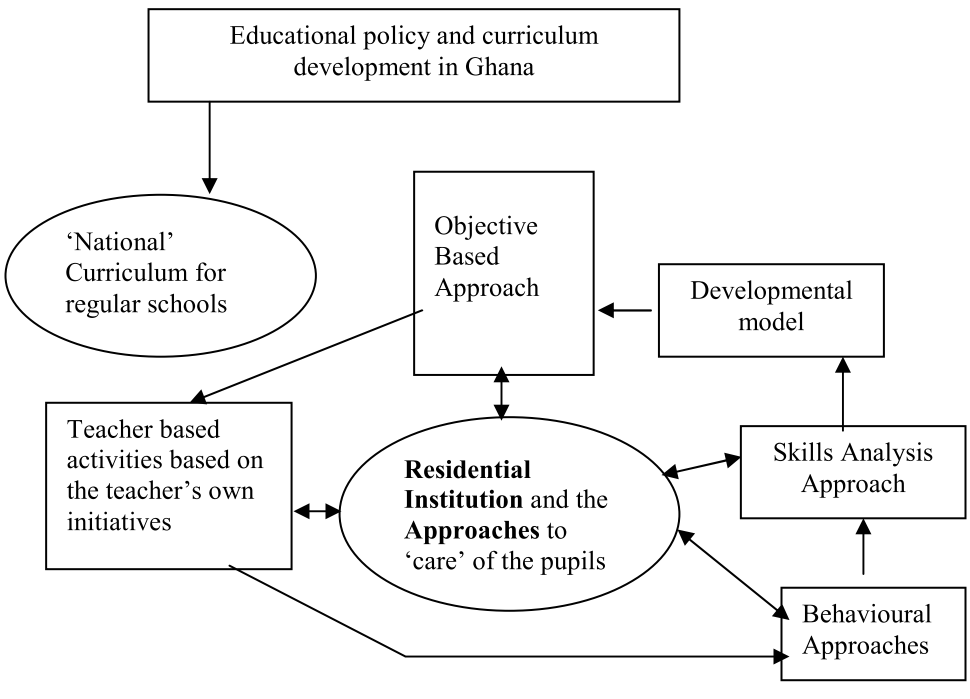
The article examines some trends in curriculum development for children with learning difficulties in Ghana, drawing some comparisons from perspectives in the United Kingdom. Reference is made to a research on the institutionalisation of children with learning difficulties to illustrate the contradictions and dilemma that exist in the teaching of quantitative concept or arithmetic to children with learning difficulties in two special schools in Ghana. The article argues the need to address the learning needs of pupils with difficulties. Example of the focus of these needs are the development of quantitative concepts and survival arithmetic through differential learning experiences, while a review of methodology or approaches to teaching is underlined. It is important to reiterate that this article is part of a major study on the institutionalisation of children with mental retardation in two residential schools in Ghana, and consequently reference is made to the research study when examples are cited from schools in Ghana.

Introduction

The article maps out the trend in curriculum development in Ghana and argues that the educational reforms in Ghana did not influence curriculum development in special schools for children with learning difficulties, which resulted in a lack of adequate progress and documentation of curriculum trends in special schools for children with learning difficulties. Aspect of the curriculum relating to the teaching of quantitative concept in two schools are examined, and the point is made that many children with learning difficulties have the capacity for arithmetic of survival, but there is some concern about how it is taught. The thesis of this paper is that the teaching of arithmetic for survival or basic quantitative concepts, should be underpinned by a relevant methodology that should aim at meeting the deferential needs of the pupils in special and regular schools. The main strands of this article are as follows:

- curriculum for special schools in Ghana,
- lack of access and ownership of the curriculum .
- quantitative concept and arithmetic in special schools,
- methodology of teaching children with learning difficulties

Curriculum development
The curriculum forms the cornerstone of successful education for all pupils, including those with special educational needs. Without a coherent and relevant curriculum the quality of education for pupils with learning difficulties will suffer (Farrell, 1997). Farrell argues that teaching techniques and approaches cannot be in a vacuum, therefore the first priority when planning teaching programmes for pupils is to decide what they should be taught. He relates that having a carefully planned and relevant curriculum should be the first priority for a school. Curriculum is however, influenced by the philosophical and educational trends and policies within specific countries and this does not seem to be the case regarding the curriculum in special schools for children with learning difficulties in Ghana.
Please see below:



The educational reforms and curriculum restructuring in Ghana had little influences on the curriculum of residential special schools for children with intellectual difficulties in Ghana, and this is shown by the lack of a link between the educational policy and the curriculum on offer as shown in the model in Fig. 1.

From the scrutiny and observation of the curriculum documents in some special schools in Ghana, it is evident from the model that teachers developed objectives alongside the lines of specific behaviours in a similar way to the Skills Analysis Model used in the 1980s in the United Kingdom. Such a model (based on learning theories) relies on reinforcement and rewards as critical to the acquisition of skills. Teachers also made use of

checklists which were devised to take into consideration the mental ages and developmental growth of the children in the schools.

It was apparent that the learning experiences of pupils in these schools was influenced largely by the personal theories of the teachers, resulting in a teacher-initiated approach to teaching, as shown in the Figure above. The influences on the teaching in the two schools, was eclectic and, consequently there was a lack of ownership of the existing curriculum which they had little knowledge of any way.

Lack of access and ownership of the curriculum

As already stated in the Figure above, the curriculum document was not derived from the educational reforms in Ghana despite the fact that the curriculum was developed within the same year (1987).

The lack of knowledge of their own curriculum documents by the teachers was apparent:

> The school curriculum! I cannot say we really have a curriculum. What we have is something to guide our teaching per se. If I tell you I have not seen a copy of that document of a curriculum you would doubt it (Teacher, Special school, A).

> We do not have any fixed curriculum even though we prepared a curriculum ten years ago in Togo, the teachers do not use it (Headmaster, Special School B).

Ironically, the (elusive) curriculum states that lessons as well as individual objectives are to be 'selected from the curriculum before teaching'. It is logical, however, that 'ownership of a curriculum is important if a school is to be effective in educating its pupils' (Sebba, Byers and Rose 1993, p.57).

The course of curriculum development for people with mental retardation in Ghana has not been as properly documented as experiences in the United Kingdom. It is therefore difficult to map out the precise developments that have taken place over the years. Clearly, while the United Kingdom, for example, has gone through many stages in the development of curriculum for all, and is now implementing one influenced by a philosophy of inclusion, curriculum in schools for children with mental retardation in Ghana continues to be at a basic stage.

When commenting on trends in the United Kingdom, however, Carpenter and Ashdown (2001) noted that the affirmation of an 'entitlement' was only a first step in the implementation of the development of a National Curriculum for all. They also acknowledged the fact that 'entitlement' was not necessarily the solution to the learning problems of children with learning difficulties. This point is supported by Ouvry and Saunders (1996), who emphasised that even though the introduction of the National Curriculum in the United Kingdom changed the focus of curriculum development towards issues of entitlement and access across curriculum subjects for all pupils:

> 'Many practitioners, who work with pupils with PMLD are still striving to achieve a sufficient integration between the subject-led National Curriculum and the developmental and learning needs of these pupils' (p.202).

Ouvry and Saunders are commenting on the education of pupils with profound and multiple learning difficulties, but one specific concern of this article is the teaching of quantitative or arithmetic skills in special schools.

Quantitative concept and arithmetic in special schools
McConkey and McEvoy (1986) found that only 75 percent of 51 children with severe learning difficulties aged 12 to 18 could recognise how many were in a set under five and only 51 children could successfully name the number of objects in a set of five and ten. According to these authors, if a child is still in the piagetian pre-occupational stage, no amount of teaching will help the child understand certain relationships. They argued that the question that needs to be asked is whether or not children with severe learning difficulties should be tested on these academics target. O' Toole and O' Toole (1989) have also suggested that a more realistic goal may well be to read the street and bus numbers, tell time, recognise different coins and be able to use the telephone.

What is critical, however, is the importance of involving children in basic arithmetic to gain the experiences of relevant quantitative concepts for their day to day activities and survival. Berger, Morris and Portman (2000) argued that teachers should involve all pupils in arithmetic lessons and ensure where possible that lessons are appropriately differentiated to cater for the needs of all, and (Germain, 2001) comments that such a trend poses a challenge to primary teachers when increasing numbers of pupils with moderate or severe learning difficulties are being included in the mainstream schools. Hanrachan and Newman (1996) acknowledged that even though there have been few investigation designed specially to look at mathematics achievement of pupils with Down syndrome, the situation has begun to change with the realisation that many pupils with Downs syndrome can understand mathematical concepts. Lorenz's (1999) work relating to the teaching of basic mathematics skills to children with Down's syndrome is worthy of note, and Germain (2001) citing Caycho, Gunn and Siegal (1991) demonstrates that children with Down's Syndrome appear to develop mathematical concepts in the same way as non handicapped children.

Skarkey and Gelman (1982) showed that children, aged between three and five years, were able to solve simple addition and subtraction problems, involving small numbers when they were asked to work out how many pennies an adult had in his hand. By using their fingers to represent the hidden objects, or counting aloud, they were able to solve the problems. The basic approach in teaching these skills to children with learning difficulties may vary from those pertaining to non handicapped children, and thus Germain (2001) citing Lovenz (1998) warned that teachers should be encouraged to differentiate work appropriately and include pupils with learning difficulties in the whole class teaching.

In research conducted by the author of this article, teachers' expressed concern that the 'curriculum' or programme of study in the schools involved in that study generally had a strong leaning towards the teaching of 'academic' skills.

> The present curriculum orientation looks too bookish for my liking. That is what I have realised (Teacher, Special School, A).
>
> I cannot say we are covering even 20% of the curriculum because most of the activities are more academic. There is too much teaching of abstract arithmetic, which makes it difficult (Teacher, Special School B).

The emphasis on the academic skill component of the curriculum in the schools for children with learning difficulties was evident in the focus group discussion with the pupils, and teachers in two residential special schools. In that study referred to in the preceding paragraph, the author used participant observation, interviews-focus group and one on one, and document scrutiny, as the main methods of inquiry. When asked what the pupils were usually taught at school, they stated that:

> Everyday it is '1, 2, 3, 4 that is what the teachers teach every day (Pupils Focus Group, Special School, B).
>
> Moths and English (Pupils Focus Group, Special School B).
>
> I am in the educable class, group 4. We draw triangle and rectangle and everything we like (Pupils Focus Group, Special School, A).

Clearly the pupils were indicating that there was a strong emphasis on mathematics. Interestingly, the Inspection Report on School, A in 1995 by the Special Education Directorate noted that:

> 'Mentally handicapped children in the educable category are able to perform at sixth grade level' (Inspection Report Special School A, 1995 p.15).

What this statement suggests is that children with 'mild learning difficulties' within that school were performing at primary six level in the regular school. Such comments were taken to be a compliment to the schools' efforts in emphasizing arithmetic in these schools.

In an examination of the schools' Inspection Report, it was noted pupils at the educable level could perform at sixth grade level, which raises the questions of why they could not be included in regular classes.
Indeed, one teacher at School A commented that:

> It would appear that most people feel that the trainable and educable should proceed after sometime to the mainstream. This is perhaps another justification for the bookish approach. Look at the type of mathematics they are taught (Teacher, Special School A).

If such a comment was meant to justify the adoption of teaching strategies that promoted specific school subjects such as arithmetic, why then were the teachers complaining that the curriculum or the programmes of study in the schools were too 'academic' or 'bookish'?

In the major study referred to in preceding pages, large number of lessons were observed. In one of the lessons, the short-term objective was stated as: 'the children should be able to identify the various shapes from objects put together'. This objective was set for a class of ten pupils, and throughout the entire lesson the teacher's medium of communication was the English language, an unfortunate choice as English was not first language of these pupils. At the time of the study, it used to be a basic requirement of the Ghana Education service that teachers should be encouraged to use the local languages during the first three years of primary school. In many special schools for children with learning difficulties in Ghana, however, the first language continues to be recognised as the medium of instruction. The consequence of the use of English for many of these children was that the quantitative concepts and other learning experiences they were introduced to invariably became meaningless, owing to the fact that the concepts are not made relevant to the pupils by teachers who should be facilitating these experiences. This apparent lack of relevance is even more serious within the mainstream and other integrated settings when children with difficulties are placed there.

Clearly some children with learning difficulties may have cognitive difficulties that could slow the general process of conceptualising aspects of these quantitative concept, which makes the methodology of teaching them an important aspect of the teaching and learning process.

Methodology of teaching children with learning difficulties

According to Rose (1998)

> 'Many of the arguments which have surrounded the relevance, or otherwise, of the National Curriculum have focused upon content and have chosen to ignore the issue of learning and pedagogy' (Rose, p.30).

Rose's point is particularly pertinent in the Ghanaian context, as methodology that is used to teach such children with learning difficulties is central to finding some of the solutions to their learning problems. Within Ghana, for example, a study was conducted by the National Programme of Action on Basic Education in 1994, which revealed that the basic schools in Ghana, (which will primary one to secondary school year eight in the UK) were generally unable to provide minimal levels of learning to the majority of the pupils. This point makes the argument about methodology very relevant.

When commenting on the National Curriculum within the United Kingdom authors such as Aird, (2001) suggested that the:

> 'Bulk of the National Curriculum was largely irrelevant and meaningless to the circumstances of many pupils with SLD/PMLD' (Aird 2001, p.1).

According to this author, the curriculum material was pitched above the ability of many of the pupils and the pace of learning was too extensive to allow for the relatively modest attainments that pupil with severe learning difficulties would make. In his opinion, teachers in schools catering for

pupils with severe learning difficulties in the United Kingdom during the 1990s were guilty of compromising the needs of their pupils in their struggle to implement the National Curriculum. Such a trend according to Aird (2001) could be described as the corporate guilt of teachers arising out of the desire to uphold the rights of entitlement of their pupils at all cost, even though they were aware of the short-comings of that entitlement.

The apparent inherent inadequacies within the National Curriculum in that country ultimately prompted the need for further review of the curriculum in order to guarantee access for all. Thus, Carpenter and Ashdown (2001) comment that it is because of the inequalities of entitlement that the debate on the curriculum moved to access. Clearly the new curriculum document brought out in 2001, (DfEE/QCA 2001) was concerned with inclusion and special needs. An inclusive curriculum invariably requires that an approach to delivering the curriculum in such a way that the learning needs of pupils is met within that context.

The importance of methodology in facilitating the delivery of the curriculum cannot be over emphasised. In the research on institutionalisation of children with learning difficulties in the two schools in Ghana, observation of the lessons in both schools showed that it was not so much what the pupils were taught that made the subjects or skills 'academic'. The concerns regarding arithmetic, in my opinion, were largely influenced by the method of delivery of the curriculum. Teachers were giving a free choice in selecting what they wanted to teach, and accordingly prepared their own lesson notes, forecasts and schemes of work. Even though the curriculum appeared to be illusive, for reasons already outlined, the presentation of the learning experiences was the main source of tension and which led to the lack of progress.

Conclusion

From this discussion, it is important to acknowledge the usefulness of arithmetic and other quantitative concept as a means of introducing children with learning difficulties to basic survival skills. However, in order that effective learning takes place, it will be important that teachers appreciate the differences in learning styles of these pupils. It will also be important for them to encourage the differentiation of task in order to promote the learning experiences of children with learning difficulties within the context on the curriculum that is on offer in schools. Such an initiative will require a critical examination of methodology and style of teaching in regular and special schools within Ghana.

References

Aird, R. (2001) *The Education and Care of Children with Severe, Profound and Multiple Learning Difficulties*. London: David Fulton.

Berger, A., Morris, D., and Portman, J. (2000) *Implementing the National Numeracy Strategy for pupils with Learning Difficulties-Access to the daily Mathematics Lesson*. London: David Fulton.

Carpenter, B. & Ashdown, R. (2001) 'Enabling access', in B. Carpenter, K. Ashdown & K. Bovair (eds.) *Enabling Access: Effective Teaching and Learning for Pupils with Learning Difficulties*. London: David Fulton.

Department for Education and Skills (DfES) (2001) *Special Educational Needs: Code of Practice*. London: HMSO.

Farrell, P. (1997) *Teaching Pupils with Learning Difficulties*: *Strategies and Solution*. London: Cassell

Germain, R (2001) Access to Numeracy: A case study. *British Journal of Special Education,* 28 (4), 182-186.

Hanrachan, J. and Newman, J. (1996) 'Teaching addition to children'; in B. Straford and P. Gunn (ed.) *New approaches to Down's Syndrome*. London: Cassell

Lorenz, S (1999) 'Thinking figures'. *Special.* Spring, 30-31.

McConkey, R. and McEvoy, J. (1986) 'Games for learning to count'. *British Journal of Special Education*, 1, 13-22.

National Programme of Action (1994) *The National Programme of Action on Basic Education*. Accra: Ministry of Education.

O' Toole, B and O' Toole, P (1989) 'From counting to arithmetic'. *British Journal of Special Education,* 16 (3),115-117

Ouvry, C. & Saunders, S. (1996) 'Pupils with profound and multiple learning difficulties', In: B. Carpenter, R. Ashdown & K. Boviar (eds.) Enabling Access: Effective Teaching and Learning for Pupils with Learning Difficulties. London: David Fulton

Rose, R. (1998) 'The curriculum: a vehicle for inclusion or a lever for exclusion?', in C. Tilstone, L. Florian and R. Rose (eds.) *Promoting Inclusive Practice*: London: Routledge.

Sebba, J., Byers, R. & Rose, R. (1993) *Redefining the Whole Curriculum for People with Learning Difficulties*. London: David Fulton.

Starkey, P. and Gelman, R. (1982) 'Addition and Subtraction Algorithm in pre-school children'. In T. Rombverg,., T. Carpenter, and J. Moser, (eds.) *Additional and Subtraction: A developmental perspective*. Hillsdale, NJ.: Lawrence Erlbaum.

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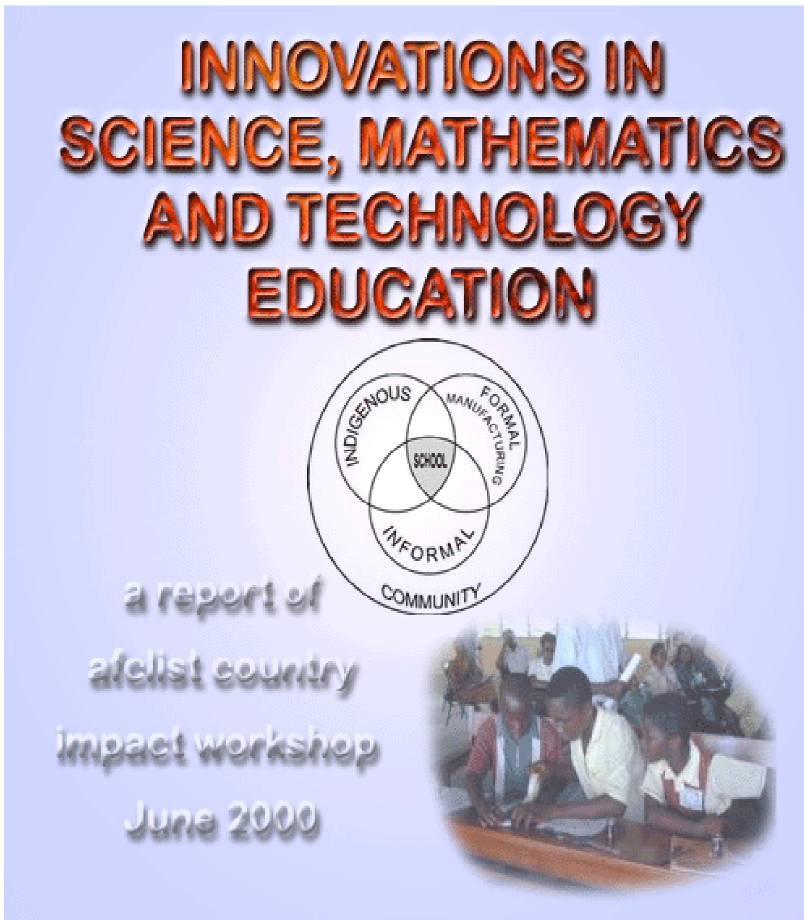

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